Building Effective Water Governance in the Asian Highlands

Living with Risks and Building Resilience in Water Governance

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READER'S GUIDE

Dear reader,
Welcome to the final technical report of the Building Effective Water Governance in the Asian Highlands project. This report outlines our progress over the lifespan of the project. Please follow the table of contents below for details of the work completed. In the introduction, you will find an overview of the project. The highlights section presents key findings. In research details and results, you will find specifics on each part of the project, including methods and results specific to each module. The outputs, outcomes, and dissemination section includes key findings and explains how we shared these results. Lessons, assessments and recommendations are found in the lessons learned section. The training and capacity building section outlines progress made in these two important areas. Given the complexity of the project, we have endeavored to tie together the results from our three study sites within the framework of our four-module approach in order to provide a complete picture of the project. We hope that by reading this report, you will gain a sense of the entire project as well as of the progress made by each country team in each module. If you have questions, please contact us using the email addresses on the title page. Finally, the report examines the importance of this research to livelihoods and environments in the region, and identifies the highlights, unexpected discoveries and main challenges towards meeting the goals of the project.

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INTRODUCTION

The Asian Highlands are a vast series of mountainous areas located at least 1000 meters above sea level. They include the Himalayan and Tibetan Plateau and the upper Mekong River, and are the sources of most of the major rivers of Asia (fig. 1).

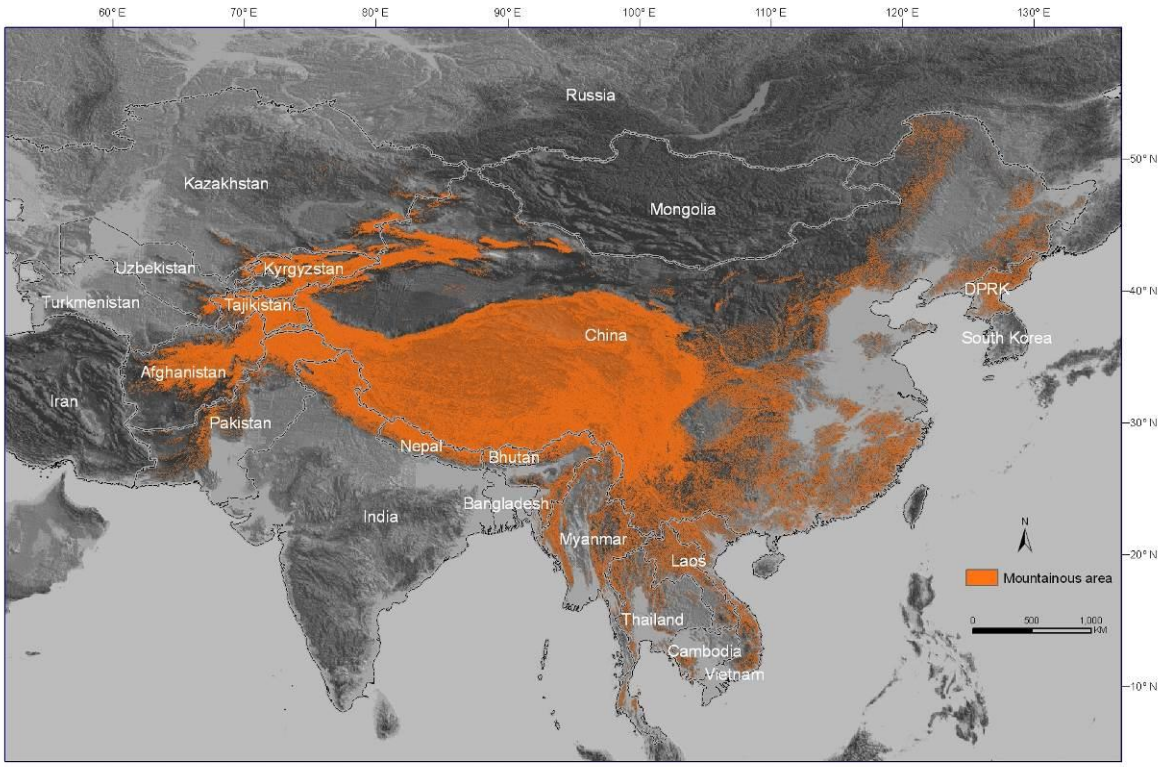

Figure 1: The Asian Highlands

This "Water Tower of Asia" directly sustains around 150 million people and has impacts on the lives of almost 3 billion people living downstream. Climate change in the Asian Highlands poses a number of known and predicted biophysical impacts affecting water resources and how they are governed. The region has been warming at greater than global average rates and projections indicate that temperatures will continue to increase by 2-4°C into the 2050s and beyond. Overall, despite much regional variation and uncertainty, rising temperatures and associated changes in precipitation and evaporation are projected to lead to reductions in soil moisture, river flow, glacial mass, and groundwater. These changes will likely lead to large impacts on local peoples who depend on water resources and often have low capacities to deal with climate change.

Climate is an important determinant of water availability in the Asian Highlands, but it is not the sole driver of change. Socioeconomic pressures on water and other resources are also increasing. Drivers include regional population growth, ongoing needs for human development such as clean water and sanitation, growing food insecurity, strong rural-urban migration resulting in changes in sectoral water demand, and overall economic integration with increasing flows of cross-border goods and services. While highland dwellers experience both threats and opportunities from these transformations, many people, particularly the poor and women, face disproportionate vulnerabilities. In the past, people in the Asian Highlands adapted to climate and social variability through diverse forms of mobility, storage and communal pooling of natural resources. However, today's private and state-sponsored economic

integration has meant that regional and global markets, which local people are unable to influence, increasingly affect villagers' community-oriented livelihoods. Local governments remain dependent on top-down policies; citizen participation in decision-making is low. Yet it is imperative to move beyond traditional top-down approaches and engage highland peoples in order to better understand linkages between biophysical and social drivers of vulnerability that may lead to resilient adaptations to change.

Across the Asian Highlands, social, political and biophysical constraints to peoples' participation in decision making also manifest in a lack of regional upstream-downstream and multilateral discussion of water resource issues. There is considerable research available that spotlights the benefits of: integrated analysis and problem solving; planning for mitigating coupled socio-ecological problems; institutional interplay that supports environmental policy integration across nations; and adaptive governance responding to climate change. In the Asian Highlands, however, little of this information has been accessed or employed.

The Asian Highlands face multiple problems which urgently demand solutions, including: limited understanding about climate change impacts on water resources; vulnerability of Asian Highlands people (especially the poor and women) to ongoing change; lack of participatory dialogue across stakeholder groups (both upstream and downstream); and low capacity to consider integrated frameworks for regional peace and security. The potential for cascading effects on Asian Highlands ecosystems leading toward "tipping points" – critical thresholds at which small perturbations may determine future large-scale ecological functions – makes the need for immediate action to minimize future risks even greater.

Ecological tipping points, local peoples' individual and community vulnerabilities, transboundary water governance--these complex clusters of influences that drive the direction of change in ecological-socioeconomic systems must be approached in an interdisciplinary manner. Given that the Asian Highlands span a vast area it would be impossible for the project to cover the entire region. We therefore decided to focus our investigation on two of the most critical zones: the highland water tower zone (elevation above 3000m) and the upland watershed zone (elevation between 1000 and 3000m). These zones are of critical importance for the fresh water supply of Asia's' nine largest rivers. As such, they are of utmost hydrological significance for sustainable water resource management.

In order to provide a broad picture of the changes taking place in the Asian Highlands and to undertake a comparative analysis, we chose three case study locations - one each in the Indus basin, Ganges basin, and the Greater Mekong sub region. Our study site in the Indus basin was located in Chitral district and valley in Pakistan. In the Ganges basin, we focused on the watershed of the Melamchi Water Project in Nepal; and in the Greater Mekong sub region, we worked in Lijiang Valley in Yunnan, China. The sites have several characteristics in common. Each is located midway between upstream and downstream in large river systems. Each site is home to populations which rely on the use of traditional knowledge and practices for their livelihoods yet are also experiencing increasing migration and population growth. Each site has hydrological significance for sustainable water resource management and is already subject to climate change pressures and resulting local adaptations, but is poorly linked to higher-level decision making. There are also significant differences between the three sites. Chitral in Pakistan struggles with managing water-induced disasters. In Nepal, Melamchi is at the center of a complex rural-to-urban water transfer scheme. Lijiang in Yunnan, China is experiencing rapid urban and rural development stimulated by tourism, even as local glaciers that supply water to the area are receding.

We used a set of four nested research modules (see Research Details and Results section) that explored these issues from villages to the catchment level to national and multi-state scales. We considered the potential impact of hydro climatic change on local people, communities and water managers across the

study region, and assessed policy barriers and options for more cooperative local and regional governance. We aimed to increase flows of new information about climate change, reduce gaps in understanding about resilient adaptations of local people, facilitate exchange between multiple stakeholders, and increase the capacity of decision makers to consider the benefits of better water governance. Our goal was to advance understanding, practice and problem-solving about building more effective water governance across this important region.

Summary of research findings

The project has been successful in analyzing projected rapid and substantial upward regime shifts in the mean elevation of both bioclimatic strata and bioclimatic zones. These shifts will force mountain farmers and pastoralists to adapt to rapidly changing conditions, modify their agricultural or pastoral management practices (selecting new cultivars, species, livestock breeds, farming systems) or migrate to areas with better opportunities or suitable conditions. These methods and tools have been adopted by the Yunnan Province of China for the ADB-supported project on the Yunnan Biodiversity Strategy and Action Plan, as well as the Mekong River Commission (MRC) for wider impact assessment of climate change in downstream rivers, which will support new highland-lowland linkages and dialogues on water resource allocation in Greater Mekong Sub-Region (GMS).

Working for better water governance beyond the local level is challenging. In Pakistan, the state is relatively weak resulting in too many institutional disconnects between policy making and on-the-ground implementation. In Nepal, national water policy *implementation* has been stymied by intractable disagreement around constitutional issues, party politics and inadequate funding. Within China's strong, relatively closed state system, there exist few avenues to influence officials above the village level. International water governance standards have had some influence at the regional level in the Asian Highlands through state-level laws and policies. All three countries in the project have strong water laws and policies on paper but implementation is weak. Equity in water distribution is lacking at all three study sites. Conflicts over water distribution are becoming common in **Chitral,** especially for villages at the tail end of distribution systems which are now poorly maintained after decades of use. In **Melamchi**, despite some special provisions to support disadvantaged groups, it remains the case that women, Dalits, Jana Jaits, indigenous people, the poor and people from remote areas have less representation and access to decision-making. In **Lijiang**, while there may be a high level of equity within a given community, there is almost no equitable water governance between levels of political decision making. The communities are already using hybrid knowledge to adapt to water and climate change impacts. "Traditional" knowledge does not exist in isolation from market and government influences.

Evidence from published research and results from team field work are in broad agreement that water governance is weak across the Asian Highlands. While details differ from state to state and locale to locale, common problems are shared widely at regional and local levels. A strong international consensus on principles of good water governance has existed for some time. These principles include: open information exchange; transparency; accountability; inclusive, equitable and ethical participatory processes; rule of law and conflict resolution. As far as decision making is concerned, community participation is generally low across the three study sites. However, participation increases significantly when local communities control their own water projects.

In the Asian Highlands, incentives for change are not yet strong enough to tip the balance away from a political status quo that so far has placed little value on policies and practices to address water governance across national boundaries. Potential tipping points toward better water governance could include: reduced economic growth due to water and climate impacts; rising temperatures that begin to constrain outdoor labor and reduce human work productivity; catastrophic climatic disasters triggering

years-long drought; a transboundary food security crisis resulting from hydropower development on the Mekong River (or another river); or some unknown combination of social responses to growing biophysical impacts that might be described as a "tipping point".

The Mountain Futures Conference took place from 1-4 March 2016 in Kunming, China with the aim of identifying new ways to generate positive social and environmental change for mountain landscapes and peoples. Over 150 researchers, representatives of mountain communities, government officials, donors, and NGOs from Asia, Africa, Latin America and Europe came together to share their visions of mountain futures and develop the means to realize them.

While recognizing the scope of the pressures faced by mountain peoples and mountain ecosystems, the conference set out to reframe mountains not simply as threatened, vulnerable landscapes but as dynamic testing grounds for innovative, effective solutions to urgent social and environmental problems. In this conception, mountains are not marginal but central to efforts to respond to challenges such as climate change, water scarcity, rural poverty, gender inequality and biodiversity loss. The conference therefore aimed to gather ideas, experiences and innovations contributed by mountain communities across the world, and to assess the potential for their transfer and application in Asian Highlands and other countries. Alongside a number of donors and co-organizers to the conference, the IDRC remained the main donor/contributor through the Building Effective Water Governance project.

HIGHLIGHTS

1. Climate modeling and biophysical assessment of change

Our assessment of climate change and its impacts on ecosystems and water resources in the Asian Highlands showed that significant impacts can be expected by 2050, including rapid and substantial regime shifts in the mean elevation of both bioclimatic strata and bioclimatic zones. These projections suggest that mountain farmers and pastoralists will be forced to adapt to rapidly changing conditions, either through modifying their agricultural or pastoral management practices, selecting new cultivars, species, livestock breeds or farming systems, or migrating away to areas of better opportunities or improved conditions. Severe impacts on biodiversity are also likely, and the results of this analysis warn of a prolonged period of climate perturbation and ecological disruption across ecological and social systems.

2. Building more effective water governance: local level

A major finding at all three study sites was the common use by village people of hybrid knowledge, where combinations of traditional, market and government support are leading to new economic and social behaviors. Hybrid knowledge is an evolving form of adaptive capacity where people are reshaping their livelihoods to include more dependence on state and private institutions such as state-sponsored infrastructure, market information and financial credit. Local level action provides many potential solutions to water governance issues in the Asian Highlands.

In **Chitral,** people are pursuing many different strategies to adapt to change, though most of these are examples of short-term coping rather than long-term adaptation. Since water tenure remains vague, a clear understanding of local water rules and assessment of persistent conflicts is needed. More support for women is essential since men often migrate away in search of cash labor and women are increasingly called upon to look after land-based resources including water resource management and taking care of the cropping lands. A redesign of conventional agriculture extension services, which are still focused on serving men, would help women with these responsibilities.

In **Melamchi**, clarity on water tenure also remains vague, though this is supposed to be addressed by various national laws. We found four areas where local water governance could be improved:
1) Consolidating conflict-laden water planning into one process help integrate planning and support local ownership and equity, therefore contributing to better water governance;
2) Championing local planning that meets central government “minimum performance measures” is one incentive that can lead to increase funding for water infrastructure and management;
3) Water Use Master Planning was one of effective tools for engaging local people on water decisions;
4) Local leaders need to continue to focus on trust building, a rights-based approach that triggers local empowerment and participation by the poor, women and marginalized people is essential to achieve good governance.

In **Lijiang**, while the government currently appears to have little interest in moving away from highly centralized water management, local people are buffered from the immediate negative impacts of change due to relatively high household incomes and state financial support for rural livelihood transformation. We found few leverage points to build more effective local water governance in the short term but disaster relief, risk reduction and efficient technological improvements can engage the state around water management due to their potential contributions to increasing economic performance. Yet, while the government shows less interest in a transition toward more participatory water governance than officials in Nepal and Pakistan, the nature of politics in China shows that change can occur quickly and funding and technical capacity are not barriers to reform as they are at the other study sites.

3. Building more effective water governance: regional level

We found that state or national government behavior across the Asian Highlands is often in direct conflict with a growing body of evidence showing that nations that implement adaptive management for water and climate change will likely be more successful at adapting to the tightening resource limits projected for the 21st century. Piloting local solutions for more effective water governance in the Asian Highlands is more likely to yield near-term progress than attempting to make change at higher levels of government. So how can success at the local level be scaled up beyond a handful of pilot projects? The clearest answer comes from our Nepal study site. With water use master planning increasingly embedded in Melamchi, the national government is now debating how to increase support. The Nepal team has designed a strategy to extend water use planning but government approval must be gained.

This illustrates a critical problem we found everywhere in the highlands: the weak links between local and national water governance action often create a loss of momentum while officials deliberate and/or funding is secured. Despite progress at our study sites, the future of more effective water governance in the Asian Highlands remains mostly in the hands of the region's decision makers. Given that healthy, functioning ecosystems provide the services that allow people to respond to change, local people, local governments and local ecosystems will be at increasing risk until more effort is expended on integrating local responses with state programs for development and conservation. Yet the local plans and actions stimulated by our teams' work through this project have contributed to new dialogues and action for change among local stakeholders on sharing responsibilities and resolving water conflicts.

4. Benefits from project outputs. First and foremost, people living in our Asian Highlands study sites have benefited from a better understanding of climate and other changes that impact their lives. This knowledge is being distributed around study site communities and their networks as well as to local government officials. This may lead to improving local peoples' next round of adaptations to change. Participants in project-led local and national dialogues benefited from opportunities to identify, analyze and discuss their own and others' water interests and needs. This has led to increased participation in decision making that influences livelihood-based adaptation to change.

But better participatory process will not automatically create better decisions; there needs to be more support from political leaders. Officials and decision makers also benefitted from exposure to new perspectives on local and regional water governance gained from interaction with peers in local and regional dialogues and information provided by experts and facilitators. A few key leaders now have access to expanded options with which to respond to current and future changes. All project team leaders and facilitators have improved skills in implementing and analyzing case studies, local, regional and national dialogue processes and in organizing and running meetings, workshops and conferences involving groups from villagers to officials and scientists.

Some 47 students attended training sessions and workshops over the course of the project. Seven Master's and five PhD students conducted their research work with the project. In Nepal, climate education activities in community schools are increasing teacher and student understanding of local climate impacts. Academic colleagues in the Asian Highlands research community are beginning to have a better understanding of the value of strategic and targeted communication in general and stakeholder dialogues in particular.

RESEARCH DETAILS AND RESULTS

The general goal for this project was to build awareness of and preparedness for effective water resource management in the Asian Highlands by encouraging local adaptive livelihood options and understanding the basis for improved regional and sub-regional water governance. We proposed the four specific research objectives: 1) Interdisciplinary assessment of climate change and its impacts on water resources at regional, basin and local levels; 2) Case studies to assess vulnerabilities and resilient capabilities of local communities to adapt to climate change; 3) Expand stakeholders' understanding of other groups' interests through sustained interaction and collaboration in facilitated dialogues at local and regional levels; 4) Engagement with key decision-makers through sharing new policy research results highlighting current trends related to Asian Highlands water governance. We accomplished this by integrating new data on projected regional climate change impacts with results from case studies at our three sites which evaluated local peoples' livelihood risks and vulnerabilities. By fostering improved understanding of and broader participation in decision making on water resources, we expected that, at least at the local level of our study sites, ongoing vulnerability to water-induced stresses could be reduced; equitable access to water resources could be increased; and approaches to more resilient water governance at various scales and levels would be identified and shared widely. We wanted to discover innovative livelihood adaptation options through working with local Asian Highlands peoples, demonstrate the benefits of more participatory and inclusive governance to decision makers and disseminate widely the lessons learned.

General Methods

We pursued this project through completing four specific research objectives:

1) Interdisciplinary assessment of climate change and its impacts on water resources at regional, basin and local levels employing the results to: a) establish a regional knowledge data base, and b) empower an expanded network of actors to contribute to Asian Highland water dialogues and policies.

2) Case studies to assess vulnerabilities and resilient capabilities of local communities to adapt to climate and socioeconomic-induced water stresses and hazards. Results will be distributed widely.

3) Expand stakeholders' understanding of other groups' interests through sustained interaction and collaboration in facilitated dialogues at local and regional levels.

4) Engagement with key decision-makers through sharing new policy research results highlighting current trends related to Asian Highlands water governance. This will provide leaders with perspectives to develop a wider range of innovative options to support more effective upstream/downstream transboundary decision making.

These research objectives were achieved by breaking the project and organizing it by four work modules:
Module 1 (Regional Climate Change Impacts Assessment): Carry out an interdisciplinary assessment of climate change and its impacts on water resources at regional, basin and local levels, the results of which were then used to: a) establish a regional knowledge data base, and b) empower an expanded network of actors to contribute to Asian Highland water dialogues and policies using new understandings of climate issues.
Module 2 (Community Vulnerability): At the three study sites, conduct case studies to assess vulnerabilities and resilient capabilities of local communities to adapt to climate and socioeconomic-induced water stresses and hazards.
Module 3 (Stakeholder Dialogues): Expand stakeholder understanding of other groups' interests through interaction and collaboration using facilitated dialogues at local and regional levels.

Module 4 (Water Governance): Carry out a survey of international water governance standards, barriers and bridges to change in governance practices in the Asian Highlands, use these results to highlight current trends, and share them with regional leaders in order to assist them in developing a wider range of innovative options to support improved decision making around water issues.

To optimize the sharing and implementation of lessons learned, it is important to note that, though the modules stood alone as work packages, they were linked together as they explored different scales of the research problem (see figure 2). For example, the scientific analysis in Module 1 was used as a baseline for the other modules, while the local and regional scale results from Modules 2 and 3 fed into the regional and national work of Module 4. (For details of methods specific to each module, see below.) Our overall research goal required integrated assessment of the results from all four modules both during and after research activities. Team and module leaders attended regularly scheduled meetings while research was in progress. At the end of Modules 1 and 2, internal workshops with all project members were held in which findings were presented with the purpose of integrating them into the specific activities of the other modules. At the conclusion of the entire research project, we prepared an interdisciplinary assessment (this report) of results integrating lessons learned from all four modules.

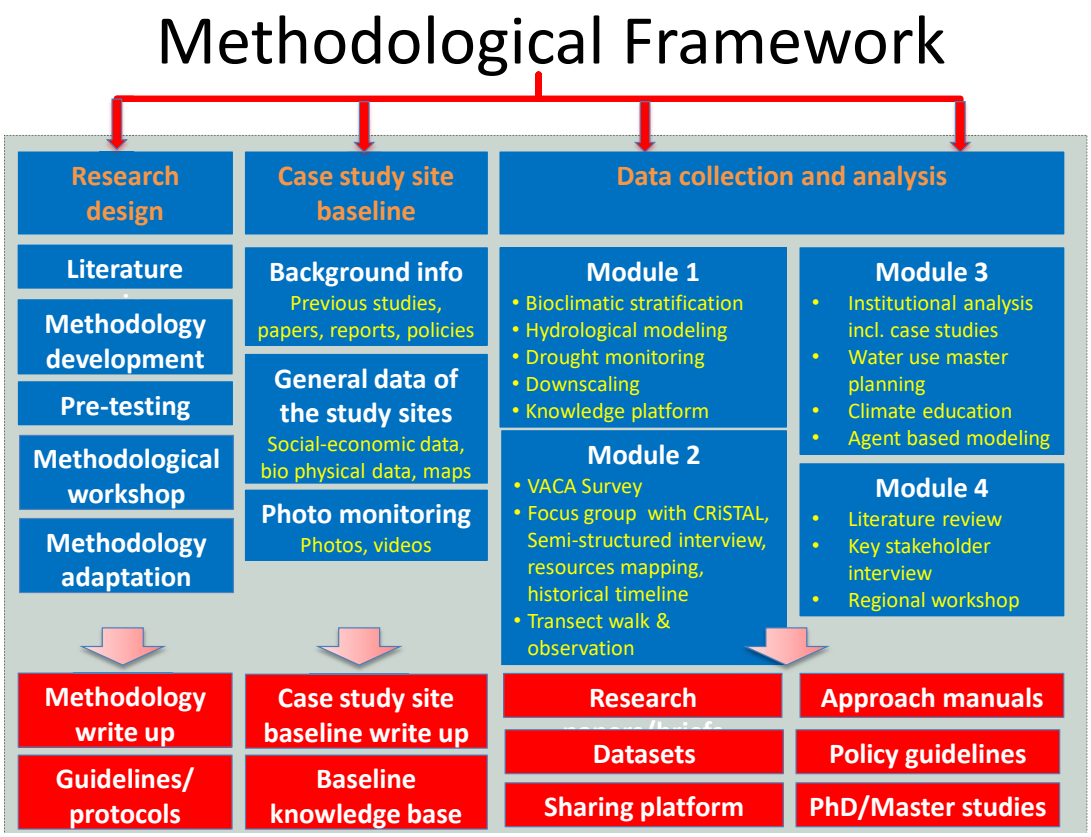

Figure 2: Methodological framework, all modules

MODULE 1

Overview

This module provided a new scientific assessment of climate change and its impacts on water resources at regional, basin and local levels in the Asian Highlands. It was designed as an integral component of the overall project; research findings and tools developed here formed a biophysical basis that was shared with all partners and stakeholders for use across all study sites. We used newly available remote sensing data derived from global and regional geo-datasets, and local (watershed, basin) data from our case studies. We produced a stratified delineation of the landscape with special attention to wetlands since they play a number of roles in the environment, principally water purification, flood control, carbon sink and shoreline stability. Wetlands are also considered the most biologically diverse of all ecosystems, serving as home to a wide range of plant and animal life. Wetlands can support environmental monitoring and identification of indicators and early warning of changes due to climate and other environmental change drivers. We improved regional scientific knowledge to support informed decision making and the development of multi-scale adaptation strategies and options with a special focus on water resources. Results formed the basis of an Asian Highlands regional knowledge base designed to be open access for easy user understanding.

Results

1. Bioclimatic Modeling of Climate Change Impacts on Terrestrial Ecosystems

We made significant progress in developing a methodology to model climate change impacts on terrestrial ecosystems at the landscape scale. The rugged, heterogeneous terrain of the Asian Highlands present challenges to large-scale analysis using remote sensing-derived datasets and other spatial data. We developed and tested a robust approach using a multi-model (19 models – 63 model scenario combinations) ensemble of downscaled Couple Model Inter-comparison Project - Phase 5 (CIMP5) Earth System Models. The projections indicate rapid and drastic change across the Asian Highlands region with significant and increasing spatial displacement of historically “normal” distributions of bioclimatic conditions. As a consequence, significant and increasing biophysical and biological perturbance for biodiversity, ecosystems, ecosystem services, and agricultural and pastoral production systems, can be expected to become increasingly prominent in the medium-term future under all of the IPCC resource conservation pathways (RCP), or emission scenarios. Our analysis highlights significant impacts expected in the highlands by 2050, including rapid and substantial shifts in the mean elevation of both bioclimatic strata and bioclimatic zones with likely negative impacts on biodiversity and local farming systems. The interaction between climate change and on-going land-use changes in the Asian Highlands were investigated as a case study focused on the current and on-going rapid expansion of rubber cultivation, and the impact that this and climate change will have on biodiversity and local farming systems in Xishuangbanna, Yunnan, China. Our results indicated that many of the current biophysical and climatic barriers to growing monoculture rubber will be removed due to changing climatic conditions, making the expansion of rubber plantations in Xishuangbanna likely. In the future, the bioclimatic range for rubber within the region, and SE Asia generally, will expand. In particular there will be an increase in the maximum optimal elevation limit, currently at about 900 m asl, but projected to increase up to 1200 m asl by 2050. This projection has significant implications for biodiversity and local farming systems. An analysis of Yunnan Province and its protected areas and found that, over the same timeline, the projected changes outlined above will disrupt the capacity of current protected areas to maintain the species and ecosystems that they were established to project.

2. Hydrological Modeling of Climate Change Impacts on Terrestrial Ecosystems

We developed and tested a regional-scale methodology for the Asian Highlands using a multi-model ensemble of downscaled CIMP5-ESM. The model is based on a simple water balance approach and is especially applicable in data-sparse regions such as our project area. The results were summarized for all three sites and provided to country team partners for their use. While the three sites all show different projected scenarios, all areas are projected to be warmer and somewhat wetter by 2050. Compared to baseline data from 1960-2000, results show projected changes in mean annual temperature, mean annual precipitation, mean annual potential evapotranspiration (PET) and mean annual aridity index (AI) (fig 3).The project areas are already facing many climate-related disasters like recent flash floods and landslides in Chitral and Melamchi while drought has been affecting Lijiang's tourist development, local livelihoods and glacier recession. Projected increasing temperatures may further impact Lijiang's tourism and water resources.

In **Chitral, Pakistan**, all climate models project high rates of temperature increase (2.3-3.5°C) by 2050. There are only slight projected increases in precipitation (2-4% by 2050). We forecast a significantly drier climate, due to increased temperatures leading to higher evaporation rates. We project little change in overall soil water balances. In **Melamchi, Nepal**, across all projections, temperatures are expected to increase by 1.8-2.6°C by 2050. Precipitation is also expected to increase, which could result in greater water availability in the Melamchi watershed. There is very little impact in terms of available water for plant growth. In **Lijiang, China**, we project increases in temperature of 1.5-2.5°C by 2050 with very little change in precipitation and soil-water balance. Overall, less change is predicted than for the other two sites.

These results should be used with caution: there is still a great deal of variability among models the CIMP5 Earth System Models, in particular, in regards to the projections of precipitation in the future. Results presented here represent a "majority" agreement amongst the models, i.e. a multi-model ensemble approach. A comparison of individual models might outline a significantly wider risk space, even in terms of the direction of change, reflecting the significant variability in mostly the precipitation projections. Nevertheless, our analysis shows, with a high level of confidence, significant impacts expected in the region by 2050, including likely substantial spatial displacement and upward shifts in the mean elevation of vegetation zones in mountainous areas. These changes would likely have disruptive impacts upon both biodiversity and local farming systems.

3. Hydrological modeling of climate change impacts on water resources at local level (Yanggongjiang watershed, China)

The Yanggongjiang watershed is located within Lijiang prefecture, northwestern Yunnan Province. The Yanggong River flows down from Yulong Snow Mountain (5596m) into Lijiang city. This ancient town in watershed is the political, economic and cultural centre of the prefecture. This region is experiencing rapid urban/rural development stimulated by tremendous growth in tourism whilst, at the same time, local glaciers that supply water to the population are receding There are significant and controversial resource conservation and sharing issues associated with land use planning, water use and resource management in this watershed. A SWAT (Soil and Water Assessment Tools) modeling approach was used to simulate hydrological processes in the watershed in order to quantify current water resource balances and impacts of future climate change. The model was calibrated and validated with satisfactory performance, and was used to simulate the effect of future climate change scenarios on water resources. Two RCPs comprised of 22 models from the downscaled IPCC-CMIP5 were used in our study. The RCP26 models project temperature increases of 1.1-2.2^{o}C and precipitation changes of between -9.5 % and 19.7% by 2050.The RCP85 models project temperature increases of 1.3-3.3^{o}C and precipitation changes of between -16.0 % and 11.0% by 2050. The average annual stream-flow will vary between -22.9% and

38.3% by 2050 under RCP26 models, and will vary between -35.9% and 11.0% by 2050 under RCP85 models. These ranges indicate increasing uncertainties when predicting future water availability which will increasingly need to be addressed by planners and land users through decision-making scenarios and stakeholder dialogues.

4. Drought Analysis

A methodology based upon a suite of recently available advanced remote sensing products was tested in order to ascertain its usefulness in data-sparse areas, i.e. areas with few weather stations such as the Asian Highlands. Using data from 2001-2010 in Yunnan Province, we found that this method was useful in drought monitoring when the area was stratified by ecoregions or bioclimatic zones.

Meteorological drought was assessed based on Standardized Precipitation Index (SPI) values, across several timescales and within four eco-geographical regions of Yunnan. Drought-prone area was identified based on LAI anomaly values. Approximately 30% of Yunnan was identified as drought-prone, and this drought risk was delineated by risk zones and mapped. Most of the drought-prone areas were distributed in the mountainous region of Yunnan. This research showed that the GLASS LAI methodology can be used as an indicator for assessing drought conditions within the Asian Highlands region, and provide valuable information for drought risk defense and preparedness. Our partner from China Climate Center has demonstrated their capacity to develop an early warning system for drought forecasting based on those methods.

5. Wetlands Assessment

Wetlands provide important buffer for too much and too little water, therefore increasing resilience of ecosystem. An innovative method using MODIS satellite remote sensing imagery was used for the mapping of high altitude wetlands (above 3000m) in the Asian Highlands. High altitude wetlands are found across the region and cover large areas of the Asian Highlands. Our analysis revealed and highlighted the extremely fragile nature of these key ecosystems, and high levels of sensitivity to climate change including substantial recent fluctuations in high-altitude wetlands in the Himalaya and on the Tibetan Plateau due to highly variable and changing climatic conditions. The loss wetlands documented in this study indicate that there is likelihood of increasing already critical water shortages. In addition, any loss or degradation of high altitude wetlands, or drying out of high altitude peatland soils, such as happens during conversion to agriculture for example, will greatly increase regional carbon emissions from the land use sector. A spatial information system is urgently needed for rapid assessment and continued monitoring of high-altitude wetlands as an indicator of environmental change in the Himalaya. In Lijiang, government invested to construct new wetlands for tourist attraction, as well as cooling down temperature therefore slowing down the glacier melting although it has no scientific base so far.

6. Knowledge Platform

A knowledge sharing platform is available on the ICRAF-HQ server (www.landscapeportal.org) and in process of development. Data sharing is in process and all spatial data results from Module 1 has been uploaded onto the server. These will form the basis for an interactive map server application, which is still in the process of being developed.

7. Crop Resiliency Modelling

Crop resiliency models we developed and tested in order to identify the impacts of climate change on cropping patterns in the Asian Highlands. Results from the models have been published, further tested in Nepal and provided in various forums in the region to support farmers to adapt to the changing mountain environment by helping to choose appropriate varieties of crops for cultivation based upon future projected conditions.

7a. Agroforestry tree modelling in Yunnan

A multi-model ensemble approach based on ecological niche modelling (ENM) was used to investigate the impact of climate on the distribution of agroforestry trees. Future changes in climatic space for 10 agroforestry tree species were projected using an ensemble of climate projections (n=63) across all four IPCC-AR5 representative concentration pathways (RCP). In addition to delineating suitable habitat, our model identified potential locations for mixed agroforestry using selected species; important locations for tea and alder-, tea and hog plum-, and walnut-based agroforestry were identified. Agroforestry was identified as an important adaptation option in response to climate change which could benefit farmers, improve the resilience of tree and crops, and enhance the restoration of the landscape.

7b. Crop modelling. Projected spatial and temporal changes in precipitation and temperature will indicate significant spatial displacement and upward shifting of current agro-ecological zones along elevational gradients in mountainous regions. These shifts will have major impacts on the viability of subsistence agriculture as well as irrigated crop production. Climate is one of the most important determinants of agricultural productivity; any changes in climate will influence crop growth and yield. Our climate change impact projections and vulnerability assessment were based on climate analogue analysis using rain-fed crop distribution from FAO's database (http://gaez.fao.org).

7c. Climate change projections

The highland and mountainous regions of both monsoonal and continental Asia are approaching novel sets of bioclimatic conditions more rapidly than the lowland plains of the region. By 2050 (i.e. representing a 20-year average between 2041 and 2060), mean annual temperatures for the Asian Highlands (averaged over all upper basins) are projected to increase by 2.5-3.1°C. All river basins in the region show increases in temperature, with the Indus Basin showing the greatest average increase of 2.9-3.5°C. Temperature increases are clearly larger at higher elevations, notably over the Tibetan Plateau. Mean annual temperatures over the Tibetan Plateau are projected to undergo an increase of between2.8-3.4°C by 2050. Notably, the Tibetan Plateau is forecast to warm from an average mean annual temperature of -1.5°C up to an average of between 1.3°C and 1.9°C, with uncertain implications for impacts on large areas of permafrost and frozen peatlands, and consequently, vast stores of terrestrially sequestered carbon. All nine river basins within the Asian Highlands region are projected to experience slight to substantial increases in precipitation by 2050. Across all basins, annual precipitation is projected to increase by as much as 39 mm to 48 mm on average. A full report and analysis of these results is provided in the publication "ICRAF Working Paper No. 222: Projected Climate Change Impact on Hydrology, Bioclimatic Conditions, and Terrestrial Ecosystems in the Asian Highlands" (see Annex 3).

MODULE2

Overview

Module 2 assessed the vulnerabilities and resilient capabilities of the local communities to adapt to water stresses and hazards related to both climatic and socioeconomic factors. Study findings were intended to contribute to the development of dialogues in Module 3 and to inform parts of the water governance analysis and discussions in Module 4.Our case study selection was based on several criteria. First, all three sites were located in upland watersheds which are the most critical for regional water supplies. Compared to often-dominant lowland viewpoints, our three case studies brought alternative perspectives from the highlands with which to provide new insights on how to build effective water governance in the Asian Highlands. Second, all three sites face great challenges from climate change: Increasing flash floods and landslides in Chitral, extreme climatic events (too much and too little water) and increasing demand for water in Melamchi, and glacier recession and urbanization and mass tourism in Lijiang, China. Therefore, they presented useful examples for exploring urban-rural as well as climate change links in water governance.Intensive household surveys and CRiSTAL exercises were carried out in farming communities' at all three locations. Composite livelihood vulnerability was prepared and current adaptive capacity was assessed using logistic regression to understand what determines farmers' vulnerability.

Results

Pakistan

At our study area in Chitral, we conducted eight CRiSTAL exercises and household surveys covering 381 respondents in 41 villages. Results from the CRiSTAL exercises indicated that the three most severe disaster risks in the study area include flash floods, avalanches and landslides/landslips. These disasters take a heavy toll on community livelihood assets including water resources, agricultural crops, infrastructure, and houses. Communities spend limited resources - especially cash income and reserves - to overcome these losses using short-term coping strategies. These unsustainable strategies further exacerbate vulnerabilities. The results from Module 1 show that overall the Chitral is both colder and drier than the other sites. And all the RCP projections predict relatively high rates of increase in temperature, ranging from 2.3° to 3.5° C by 2050. Annual precipitation for the area is relatively low (566mm), with only very slight increases (2% to 4%) predicted by 2050. The case of Chitral indicates the importance of developing policies that encourage the government and development agencies to invest in understanding risks and *long-term adaptive* strategies so that local communities invest less of their scarce livelihood assets on *short-term coping* strategies. Risks and hazards associated with climate and geological changes such as landslides and landslips are inevitable in the youngest mountain areas of the world and may have been exacerbated in recent decades.

Nepal

We conducted six CRiSTAL exercises in this study area, of which three were for men and three were for women. We interviewed 365 local household heads (37 female and 328 male, 30 to 80 years old) from eight village development committees to better understand local exposure, sensitivity and adaptive capacity to climate change. About 95% of respondents stated that temperature had increased over the previous two decades. Local perceptions coincide with the meteorological record of increasing temperatures. This is also evident from the results from module 1 indicating increase in the mean annual temperature from 2.2 ^{o}C (RCP2.6) to 3.3 ^{o}C (RCP8.5). Local people reported that change is already occurring with drought as the primary hazard, while surface waters have been reduced. Outbreaks of pests, including new crop pests, are another hazard. Major impacts from these hazards are felt across agriculture and water resources.

The livelihoods of farmers, especially in developing countries, are directly dependent on climate-sensitive sectors such as agriculture. High population growth rate, urbanization, natural resource degradation along with poverty and food insecurity make this region one of the most vulnerable to the impacts of climate change. The impacts will be heaviest on smallholder farmers depending on rain-fed agriculture which constitute the majority of farmers in this region. In response, farmers are shifting the cultivation calendar, switching to other crops/improved seed varieties, diversifying income resources, and using temporary measures like taking out loans to meet increasing financial demands and gaining cash from labor-based migration. Middle watershed farmers appear to be more vulnerable than those at higher or lower elevations. People want to maintain the irrigation canal system and receive training and seeds for new varieties that are resistant to droughts. Landslides are the major hazard in some wards.

China

Results from our Vulnerability and Adaptive Capacity Assessment (VACA) questionnaire (conducted in 432 households at 16 villages) and CRiSTAL surveys (conducted at three villages with six groups) show that according to the villagers (97% of surveyed households) temperatures have risen significantly, the amount of precipitation has decreased, the snow line has risen and glaciers have retreated. The results of module 1 confirm that annual mean temperature in this area has increased on average by 1.4^{o}C every ten years for the last sixty years. The Mean Annual Temperature is also projected to increase between 1.5° to 2.5° C by 2050 in Lijiang. Right now, however, people are adapting more to government policies and overall economic changes than to climate. Compared to government water policies and impacts from tourism development, climate has yet to become a major issue for local people. To deal with recent droughts along with government-mandated water transfers, people are saving and storing water more often, digging wells, and moving into the tourist economy to find cash jobs. Water is managed by the government in a top-down manner. Driven by huge budgets allocated for infrastructure and the government's focus on tourist and city/urban development, there are almost no participation channels for local people. There is also inequitable distribution of water resources, with city uses dominant over rural uses.

Improving local water governance in Lijiang requires political will. At present, however, government agencies have little incentive to increase participation, cooperation, open information exchange and other hallmarks of good water governance. There are opportunities to improve water governance by linking water governance policies to local farmers' strategies to adapt to environmental change. Improving water resource management is a long-term task requiring a holistic approach, but without more government interest in doing so, developing better water governance will be a difficult task.

MODULE 3

Overview

Module 3 focused on how to expand stakeholders' understanding of other groups' interests in water management using interaction and collaboration in multiple facilitated dialogues for the preparation of water use master plans at local and regional levels. We used these dialogues as mechanisms to disseminate knowledge from Module 1 (regional scale) and Module 2 (local scale) and assist local communities in translating this knowledge into effective decision-making mechanisms. In Nepal, we also promoted climate change education and better water governance at local schools and communities. Initially, this module included an agent-based modeling component but this was dropped as non-essential. Also, Module 3 was at first only designed for implementation at the China and Nepal sites but during our team meeting in 2014, we decided that the Pakistan site would be included. Helvetas Swiss Intercooperation Nepal, with contributions from Kunming Institute of Botany (KIB), provided a part of their budget to the Pakistan team in order to carry out these module activities.

Results

1. Information sharing
Information on climate and hydrological scenarios is easy to access in the scientific community but is not available to local communities in forms appropriate to local context and understanding. Local stakeholders and institutions do follow planning processes, but these processes often lack information on the availability of local water resources, the adverse effects of climate change on water and the resulting impacts on livelihoods. Yet the prioritization of water needs and adaptation to adverse impacts of climate change must build on solid scientific information that can provide baseline information for participatory decision making. Local communities are often at the edge of water scarcity; this is often due to poor management rather than physical scarcity of water. Communities suffer from governance issues, top-down approaches, weak local institutions, poor delivery of services, unclear water tenure, ad hoc planning, low funding, and long standing water-related conflicts.

2. Policies and actors. The effective stakeholder dialogues have been achieved and knowledge disseminated based on our key findings from climate impact assessment (Module 1), and our household surveys and CRiSTAL exercises (Module 2). The participatory dialogue have resulted in good water resource planning at Village Development Programme (VDP) level. All gender, caste and social groups were encouraged to participate in the process. These dialogues provided for information exchange among local communities and government which helped people to realize the importance of better planning, management and implementation.

3. Water use master planning (WUMP)
In Melamchi, Nepal we introduced WUMP as a participatory planning tool for promoting dialogue among community members, local government and wider stakeholders. WUMP was also a means to engage local communities in addressing climate change adaptation in the water sector. We used WUMP in four Village Development Committees (VDCs); a total of 4551 households were involved. We surveyed 784 water sources, of which 658 were springs. Only 124 sources were found to have the capacity to discharge water at more than one liter per second. Using the WUMP process, we assisted experts and stakeholders to understand how the government's policy guidelines can be translated into practice on the ground, and this has created a pool of stakeholders who can better understand, participate in and improve water policies and systems. As a result, we are now collaborating with ICIMOD's Koshi Basin Programme for developing WUMPs for four more VDCs in the Melamchi watershed. Another consortium project from ICIMOD, HELVETAS Swiss Intercooperation, Advanced Center for Water Resources Development and Management (ACWADAM), Harvard University, George Washington University and

Atom Solar, "Reviving springs and providing access to solar powered irrigation pumps through community-based water use planning: Multiple approaches to solving agricultural water problems in mid-hills and Terai in Nepal and India", will conduct spring restoration work in the Kiul VDC in our project area. The Nepal team also visited Pakistan in order to hold a workshop on how to introduce, modify and adapt WUMP to Pakistan. The Pakistan team has now developed a manual on WUMP and initiated the process, and four steps are already completed**.** However, due to devastating floods in July 2015 in Chitral, the WUMP process was completely halted. It will be resumed again in March/April 2016.

Compared to Integrated Water Resource Management (IWRM), the dominant water management framework in the Asian Highlands, there are some weaknesses in the WUMP process. WUMP does not take into account the entire hydrological cycle and does not distinguish between stocks and flows coming from rainfall, soil moisture, water in rivers, lakes, and aquifers. WUMP also does not consider the total watershed or basin; it is a very localized process. Nor does WUMP take into account changes in water flows over time, i.e. seasonality. Complete annual water budgeting is not part of the WUMP system. To address these issues, we are developing a Local Integrated Water Resources Management Plan (LIWRMP). This will allow WUMP to be accommodated within the IWRM process, allowing local government and communities to exchange knowledge, acquire and obtain ownership over water management plans and agree on water responsibilities. In both the project sites in Nepal and Pakistan, there are currently on-going projects funded by other donors including SDC with Helvetas Swiss Intercooperation. These projects are taking forward the WUMP process, addressing the weaknesses and ensuring its integration into the IWRM process.

4. CRiSTAL: CRiSTAL results from Module 2 were applied in four communities in Melamchi to document local communities' perception of climatic and livelihood hazards. We helped local communities to describe important resources and resource hazards, and villagers drew up vulnerability rankings. We found that, since 2003, drought has been the major hazard in upstream communities. Impacts include fewer crops, drying of water bodies and increased human disease. As noted in Module 2, villagers want to maintain the irrigation canal system and receive training and seeds for new varieties that are resistant to droughts. Landslides are the major hazard in some wards.

5. Stakeholder dialogues

In **Nepal**, stakeholder dialogues were conducted to verify the indicators of change observed from the Module 1 study of regional climate change impacts and community vulnerability, and to come up with strategies to address issues identified by the community. We also used results from the WUMP process. During the stakeholder dialogues we presented all of our study results as well as those from other projects and programs that are active in the area. Dialogues in the eight VDCs of the Melamchi watershed on allocation of VDC funds and Social Upliftment Programme funds for the water sector were held. Results were carried forward to clusters of VDCs in the broader Melamchi Watershed which provided for sharing of knowledge.

In **Pakistan**, dialogues were conducted at three levels in:
1) Eight clusters of 41 villages at the very beginning of the study;
2) At the district level including government line agencies, specialized departments, district authorities, universities, NGOs and other development projects, which was crucial since financial decisions rest with these local authorities; and
3) Provincial and (where possible) national levels to showcase local case studies, provoke soul-searching for policy improvement and at minimum, help to make Asian Highland water issues more visible.

In **China**, two stakeholder workshops were held. The first shared information and results from our Lijiang site regarding local vulnerability and resilience. This helped to expand stakeholder understanding

of the impacts of climate change on water resources and local livelihoods, and of the multiple viewpoints that exist surrounding these issues. We also engaged with decision makers to provide a wider range of innovative options to support more effective water governance mechanisms. A second regional stakeholder dialogue was held during the Mountain Futures Conference with participation from all three countries in the project. Questions discussed included: how are governments responding to change? Are leaders and institutions pioneering new policies and programs, struggling to adapt to new conditions, or attempting to maintain the status quo? We found striking similarities in both barriers and bridges to effective water governance even though conditions vary between and within countries. For example, the three countries in our study all have strong water laws and strategies on paper, along with some active projects on the ground. But a mix of political, institutional, and capacity barriers as well as a lack of appreciation of local circumstances often prevents effective implementation. The principles of IWRM form part of the basis for managing water in China, but there is little coordination between multiple competing ministries, data sharing is limited, bureaucratic barriers abound, and water tenure remains obscure. Water policies are often simply interpreted as water projects and implemented by a single-line agency. In addition, public participation at any level of politics in China is weak or missing. For example, China's largest water scheme, the South—North Water Transfer project, has almost no room for local people affected by the transfer to provide input. In fact, to the extent that meaningful participation requires some measure of power sharing, it would be in conflict with government norms and behaviour.

6. Documentary

A joint documentary was developed by the Pakistan and Nepal teams. The Nepal team had the lead role in compiling and editing the documentary, which covered both Module 2 and 3 results and supplements the already available documentary on the Asian Highlands, produced by the World Agroforestry Centre (ICRAF) and KIB.

7. The Mountain Futures Conference

The Mountain Futures Conference took place from 1-4 March 2016 in Kunming, China, which has brought and addressed four key themes such as the assessment of sustainable mountain development, good governance, mainstreaming the marginalized, and dynamic sustainability. The goal was to identify new ways to generate positive social and environmental change for mountain landscapes and peoples. Over 150 researchers, representatives of mountain communities, government officials, donors, and NGOs from Asia, Africa, Latin America and Europe came together to share their visions of mountain futures and develop the means to achieve them. The project results have also been widely shared and disseminated through the conference.

The conference began by setting out the challenges faced by mountain communities and their potential to foster innovation. Speakers at the opening High-Level Roundtable reminded participants of the mountains' multiple roles: providers of ecosystem services, harbors of biodiversity, centers of spiritual reverence and storehouses of valuable traditional knowledge.

The exchange of ideas and learning lessons from past experience were at the forefront of some of the conference's first parallel sessions, including presentations by young researchers of new methods for monitoring and assessing change in the mountains, the results of assessment programmes by ICIMOD, MRI and UNEP, and a session which drew on the work previously carried out under the Building Effective Water Governance in the Asian Highlands Project carried out by ICRAF and Helvetas Swiss Intercooperation. A special session on "seeds" sparked discussion by testing ideas against different future scenarios, forming coalitions between different seeds and then ranking their performance. A variety of initiatives were compared and

evaluated, including a mobile app to help limit damage from natural disasters, a locally produced bio-pesticide, and meso-scale governance platforms to support small-scale sustainable practices.

Discussions on community-based conservation, sustainable forest management and the use of wild fungi alongside an examination of transboundary water governance in the Asian Highlands. How to rethink approaches to development in ways that integrate the priorities of marginalized groups, traditions and concepts. Many of these debates emphasized the necessity of tackling established power relations, of thinking critically about our own assumptions, and of being prepared for complex, long-term commitments in order to bring about change. How to translate research outputs and policy goals into actions that make a real difference to lives and environments in mountain regions. Examining the challenges of engaging with policymakers in order to achieve results, while research from the Himalayan Climate Change Adaptation Programme, as well as examples from Nepal, Pakistan, China and Uganda provided grounds for much discussion on how to implement high-level goals into locally appropriate actions.

Cinema showings of several films examining the tensions between traditional mountain livelihoods and aspects of modern life such as tourism, resource extraction and consumerism. Filmmakers and representatives of the local communities featured in the films joined the audience for discussion of the issues raised, including how best ensure that mountain peoples have the means to voice their own perspectives through film and other media, and the ways in which researchers, policymakers and others can learn from the sustainable practices documented in the films.

The conference also laid the foundations for future projects which will continue the work of fostering mountain-centered innovation and giving voice to the needs and priorities of mountain communities. First, the conference gave participants the opportunity to contribute to planning a forthcoming book which will illustrate both the challenges facing mountains and the solutions that are being developed through the collaborative efforts of local peoples and researchers. Second, over the four days of the conference a documentary team shot interviews of participants sharing their visions for mountain futures. This will form the basis for a set of videos exploring the ways these visions can be realized. Third, proceedings of the conference will be published by ICRAF/KIB in order to provide a permanent record of the many valuable inputs provided by the participants. Finally, the conference saw the launch of the Mountain Futures Initiative, which will serve as a coordinating mechanism for these and other future projects. It will aim to pull together the expertise from several partner organizations in order to establish a sustainable basis for identifying and developing seeds of positive mountain futures.

MODULE 4

Overview

Module 4 explored key water governance issues from the village (with the assistance of the Nepal, Pakistan and China teams) to regional levels with reference to international standards. Some of the key questions we asked were:

1. In a region where water resources are of paramount importance, how are governments responding to change?
2. Are countries in the region well-informed about and following international trends in best practices in water governance?
3. Are authorities cognizant of traditional water management practices? If not, what can be done to improve local and regional adaptation to changing conditions going forward?
4. Are leaders and institutions pioneering new policies and programs, struggling to adapt to new conditions, or attempting to maintain the status quo?

These questions formed the heart of Module 4 work in Pakistan, Nepal and China as we explored how to build more effective water governance in the Asian Highlands. Module 4 was cross-cutting across all the modules in this project, and the results from the three field study sites and much of the work accomplished by other team members was crucial to answering these questions.

Results

1. Methods

As a basis for new knowledge generation, we performed comprehensive literature reviews which covered: regional climate change impacts and their influence on local and regional adaptive capacity and behavior; the development of hybrid knowledge; existing national and customary water law and policies; and water governance standards both international and across the study region. On an ongoing basis throughout the project, we reviewed results from all three modules and we visited all three study sites, some several times, to better understand research processes and results. This allowed us to link together new learning across all modules using module 2 and 3 results from household surveys, focus groups, key informant interviews, the water use master planning process, several dialogues among stakeholders and a variety of risk and vulnerability analyses. Finally, we participated in one local stakeholder dialogue (with multiple sessions) in Pakistan in 2015 and one regional dialogue at the 2016 Mountain Futures conference with stakeholders present from all three countries in the study.

2. International standards of good water governance

Our research revealed that a strong international consensus on principles of good water governance has existed for some time. These principles include: open information exchange; transparency; accountability; inclusive, equitable and ethical participatory processes; rule of law and conflict resolution. However, these principles must be recognized as standards and goals; there is no perfect water governance anywhere. Researchers have also found that effective water governance is neutral in terms of political system; that is, these principles should apply in any country at any time. One way to think about “good” water governance is to consider the chances for success when the alternative of each principle is applied (i.e. low levels of open information, little transparency; exclusion of important groups; little or no participation, etc.)

3. Regional frameworks for water governance

International water governance standards have had some influence at the regional level in the Asian Highlands through state-level laws and policies. The three countries in our study all have strong water laws and strategies on paper along with some implementation on the ground. But a mix of political,

institutional and capacity barriers as well as lack of appreciation of local circumstances by high-level leaders often prevents effective implementation.

Pakistan has several pertinent drinking, sanitation and agricultural water laws. Pakistan has also developed its Water Vision 2025 which is guided by demography, technology, social factors, environmental issues, governance and an increasing role for markets. But there has been very little implementation and provinces are still reluctant to take the lead to define strategies and policies. Barriers to implementation – fragmented institutions, lack of local participation, little and/or irregular funding, rigid implementation procedures, conflicts within and between customary, provincial and central authorities-- have been identified in multiple studies. These problems result in significant economic costs and impede provincial-level adaptation to both water management and climate change adaptation.

Nepal has a National Water Plan that uses Integrated Water Resource Management (IWRM) as a framework for action. In addition, the country has a National Adaptation Plan of Action (NAPA) linked to local climate action plans that incorporate water issues. Nevertheless, as in Pakistan, there are few implementation plans and little funding, and there are unresolved conflicts between local and central government authority, a lack of local knowledge of national planning, unclear land tenure, and little integration between central government frameworks and local-level actions. In fact, some authors point out that due to recurrent political upheaval, government in Nepal is not "coherent or consistent". Government actions remain mostly local and donors often support short-term projects.

China's strong one-party government is certainly capable of coherent governance and this is reflected in its national water laws and policies. Water is owned and managed by the state in a highly centralized, hierarchical manner covering allocation, permits and fees. The principles of IWRM form part of the basis for managing water in China but there is little coordination between multiple competing ministries, data sharing is limited, bureaucratic barriers abound and water tenure remains obscure. An example of barriers would be that, despite multiple parties' interest in a given water issue, interpretation and implementation of policy is often carried out by a single dominant line agency. In addition, public participation at any level of politics in China is weak or missing (see results from Module 2). In fact, to the extent that meaningful participation requires some measure of power sharing, it would be in conflict with government norms and behavior.

4. Local-level water governance

We evaluated the extent to which the principles of good water governance identified in the literature review were or were not being put into practice at each of the three study sites. We did this by a) using international standards and definitions on good water governance derived from a comprehensive literature review and then tying these into published works focused on all countries in the Asian Highlands; and b) reviewing study site results from module 2 that confirmed or disproved findings from the literature. (Our analysis has been peer reviewed and published; see Xu and Grumbine 2014 (2 papers) and see also Su et al. 2016.) Given that projections (from module 1 results and virtually all published work done by others) show increasing climate impacts going forward, the main problem in the Asian Highlands is that the capacity to manage water will need to be better *informed* by science and also *reformed* with an eye toward matching more closely the international consensus that clearly defines "good" water governance. That this will be challenging to accomplish in the highlands is evident from the following brief discussion of water governance principles which we link to specific findings from the three study sites.

Open Information

A basic tenet of good water governance is open sharing of information about specific problems. At all three study sites, we found that such sharing is rare. In **Chitral**, **Pakistan,** though villagers directly manage springs and water channels and often share information, there is little contact with district officials. We found that the lack of knowledge among people, particularly women, about services available from the government is a barrier to finding solutions. In **Melamchi**, **Nepal,** due to a lack of education, unclear water tenure rights and confusing legal provisions, information about various water projects is also lacking. The major challenge of open information lies in the lack of technical skills and resources to generate information. This limits the access of local government to quality information and hinders development projects. In **Lijiang**, **China**, many water projects are implemented but project funding is often allocated based on personal relations or connections to government officials. Little information on water development is available or exchanged in public or at the local level. (This trend has also been found with information about climate change at the local government level in China).

Transparency

In **Chitral**, water management happens through three groups: first, through the community, but with a customary approach and following tradition; second, through the community, but taking a modern approach with NGO support; and third, through the District Government. Decision making is transparent, but district decisions do not often trickle down to the community. However, communities are strongly knit together by community-based organizations and these groups' access to leaders provides a platform for better information sharing and transparency. In **Melamchi**, it is often the case that most local people are not notified about legal decisions, plans and processes related to state water programs. Program documents, procedures and work progress reports are rarely made public. In **Lijiang**, people mainly gain knowledge about water actions from village committees and the township administration. Transparency is low; after decades of top-down management, most local people expect not to be involved and only hope the government will provide higher water transfer quotas and compensation fees.

Accountability. Accountability (responsibility), around decisions about water is problematic at all three sites. In **Chitral**, most people belong to the Ismaili sect of Islam and have received a great deal of support in the past from the Aga Khan Rural Support Programme. In most cases, people consider this group, the Livelihoods Programme and Water for Livelihoods and other development projects as important for information sharing and accountability. Module 2 household surveys clearly identified the need for better village leader accountability. In **Melamchi,** despite a national self-governance act that promotes downwards accountability on paper, officials appear accountable only towards superiors and donors, and much less so to the general public. Officials often form corrupt alliances with outside contractors working on local projects. People are divided based on caste, ethnicity and political party and this impacts water access among different groups. Accountability is centralized in **Lijiang** as all decisions are top-down. Local people often look to village leaders, township government, and the water bureau for accountability, but villagers may not be clear about who is responsible for what. Local people think decision makers give too much priority to municipal and tourism development. We found no evidence that decision makers want to have more accountability for their decisions.

Participation. Participation at the local level is quite strong at the Pakistan and Nepal study sites. In **Chitral,** people actively participate in water management including annual channel cleaning and financial contributions for repairs. Women seem to be much more active in this regard since men are often unavailable due to seasonal migration for work. In **Melamchi**, due to the work undertaken for this project, local communities are very active in defining water use master plans for themselves, getting VDC support for implementation and maintaining water structures in a participatory manner. In **Lijiang,** participation is not as strong.

As far as decision making is concerned, community participation is generally low across the three study sites. However, participation increases significantly when local communities control their own water projects. Almost half of **Chitral** community members consider themselves to be in a position to influence the decision making of local leaders. But there is little participation from district officials mainly due to the lack of resources and the effort involved in visiting remote areas. In **Melamchi,** decision making is rarely coordinated among government, non-government, private sector and local stakeholders. We also found that the participation of disadvantaged groups was lacking mainly where leadership representing such groups was absent. Initiating a water use master planning process in Melamchi was key to building trust through villager participation in mapping critical water sources throughout the study site. However, disadvantaged and underrepresented groups had less influence on water decisions. The situation is similar in **Lijiang** where lack of participation is characteristic of decision making. Institutionally in China, there are very few channels for community participation in water governance. Villagers want more participation but from the perspective of local leaders and officials, there is little to no need for this.

Equity

Equity in water distribution is lacking at all three study sites. Conflicts over water distribution are becoming common in **Chitral,** especially for villages at the tail end of distribution systems which are now poorly maintained after decades of use. In **Melamchi**, despite some special provisions to support disadvantaged groups, it remains the case that women, Dalits, Jana Jaits, indigenous people, the poor and people from remote areas have less representation and access to decision-making. In **Lijiang**, while there may be a high level of equity within a given community, there is almost no equitable water governance between levels of political decision making. Water is transferred and allocated to Lijiang City for urban development and tourism, and compensation to local people is set by officials. All major cross-scale decisions are top down; even local village leaders are simply informed about what has already been decided.

Rule of Law

Each country in our study has national water laws but these laws are often not implemented consistently at the local level. Governance takes place according to rules of power, not rule of law. In **Chitral**, local traditional practices vary from valley to valley and there is little evidence of any national water law being implemented on-site. In **Nepal**, there are multiple policies, laws and rules which are in conflict; there is a lack of clarity about the roles and responsibilities of various agencies and staff. Frequent and sudden changes in policies at the central level make for a confusing working environment for local authorities. In **China**, rule of law is poorly recognized and implemented. For example, though deep water wells are illegal, many are constructed by wealthy people and/or high-level officials.

Conflict management

In **Chitral**, many people avoid discussion of substantive water issues. Villagers tend to solve conflicts through holding dialogues and people often look up to external NGO mediators. In **Melamchi**, ownership and use of water are sources of conflict. In theory, all water sources belong to the state yet the state has only limited capacity and resources to manage them. In **Lijiang**, when conflicts over water use arise, villagers and village committee leaders are the main managers. If the conflicts cannot be solved at the village, township, district, or city level then local officials step in. However, given the lack of cooperation across agencies responsible for water, issues that demand large-scale (watershed level) management are difficult to solve in this hierarchical manner.

Evidence from published research and results from team field work are in broad agreement that water governance is weak across the Asian Highlands. While details differ from state to state and locale to locale, common problems are shared widely at regional and local levels. These include:

- Lack of access to information about water; this includes scientific information that is understandable

to local people and politicians
- Unclear water (and land) tenure
- In general, lack of intra-and-inter-community dialogue mechanisms (recognizing that the "community" is not a homogenous entity, and that relationships between highland and lowland communities are dynamic and changing)
- Little accountability for decisions by national and regional government
- Low levels of meaningful participation, where local people actually influence decisions
- Uneven implementation of rule of law due to uneven voices and uneven power relationships
- Low capacity to resolve conflicts

Most of these problems are not amenable to technical, scientific solutions. Due to inequities in political, social and economic power, local people simply do not have much access to information or participation in decision making. These issues represent political and social barriers whose resolution requires political influence and timelines that go beyond grant-supported studies.

5. Accomplishments

Module 4 brought to the entire project a general framework for good water governance. We also developed a project-wide understanding and appreciation of the importance and influence of hybrid knowledge. Module 4 integrated results from all four modules into a shared local to regional water governance overview. We pushed for researchers (and donors) to become more politically savvy about the limits of using science to influence regional decision making in the Asian Highlands. At a relatively small scale, we successfully disseminated research results to regional and national decision-makers (see details in the section on Dissemination section). At two of the three study sites (Nepal and Pakistan), new knowledge and pilot projects for implementing better water governance were established and made progress. In China, we learned more about barriers and bridges to change, but could not initiate any new projects that might be influential in the near-term. What matters most is that the local work in Nepal and Pakistan, especially around WUMPs, has been initiated and is setting the stage for success into the future. At the national level, local success in Nepal has already had some influence as the state is considering more support for WUMPs across the country. In Pakistan, the work of the Climate Change Centre is now well-established and there are strong ties between the Agricultural University in Peshawar and KIB. The regional stakeholders' dialogue has cemented relationships with some high-level stakeholders who were already allies in supporting this project.

6. Main challenges. There were three challenges in Module 4: the first was process-oriented and the remaining two concerned results. First, Ed Grumbine's employment at KIB ended with 1.5 years of the project left to go, and as a result less work was completed than initially planned. One relevant goal that was not met was translating results from Module 1 into a story-based summary or policy brief for non-scientists. This is important because to take steps toward more effective water governance, one must link effective science communication, analyses that recognize the critical roles of power and politics and knowledge of incentives for change.

There were also two main challenges regarding results. First, the time it takes to achieve significant changes at the local level is illustrated by the fact that 4 VDCs in Nepal created successful WUMPs over the lifetime of the project, yet there are over 3,000 VDCs in Nepal, many of which would benefit from WUMPs. The time and cost involved in carrying out a country-wide WUMP effort has never been calculated. In Pakistan, groundwork was laid for doing WUMPs, but major flooding caused delays. These plans are still in progress. It is yet to be determined whether the Pakistani state will embrace this kind of planning in the same way as the Nepali government appears to be doing.

Second, in China, we learned a lot about barriers to WUMPs but not about how to begin to overcome those barriers. At the national and regional levels of water governance, work from this project has not yet become influential. It is difficult to engage higher-level politicians in most Asian Highland countries and we were not able to develop the connections to do so over the lifetime of this project.

OUTPUTS, OUTCOMES AND DISSEMINATION

Outputs

In the context of the specific research objectives and results listed above, major project outputs were:

1. Improved scientific understanding and monitoring of climate change impacts at the regional level in the Asian Highlands based on new spatial analysis and remote sensing results.
2. Incorporation of climatic scenarios into ecosystem-based adaptation planning (regional level and Mt. Kailash), for protected areas and biodiversity conservation (Yunnan Province, China).
3. Better and more nuanced understanding of the vulnerabilities, resilience and adaptations of highland communities in the face of ongoing linked climate and socio-ecological impacts.
4. Documentation in publications and multi-media presentations of resilient adaptation strategies to water stresses, targeting a variety of audiences from villagers to the general public to government officials. A detailed list is included in Annex 3 of this report.
5. Policy guidelines and recommendations for adaptation strategies to climate-induced water stress that are being communicated in the region, targeting groups from villager networks to policy and decision makers.
6. Initiation of ongoing discussions among key decision makers regarding new perspectives on the benefits of better water governance and cooperative behavior for regional security.
7. The Mountain Futures Conference and initiation of the Mountain Futures book and Mountain Futures Initiative.
8. 14 students were trained, leading to 7Master's degrees and4 PhD degrees.
9. The Centre for Climate Change in Peshawar, Pakistan was founded and is providing leadership in local and regional climate adaptation actions.
10. The Centre for Mountain Ecosystem Studies in Kunming, China has been strengthened and recognized for its regional excellence in transdisciplinary research in water governance, in particular on coupled social-ecological mountain systems.

Outcomes

1. First and foremost, people living in Asian Highlands communities benefited from a better understanding of climate and other changes that impact their lives. This knowledge has been distributed widely around the study site communities and their networks as well as to local government officials. This will lead to improving local peoples' next round of adaptations to change, and also help them to better represent their local political interests around climate adaptation and water issues. In addition, the methods and tools from Module 1 have been adopted by the ADB-supported project on the Yunnan Biodiversity Strategy and Action Plan, as well as by the Mekong River Commission (MRC) for wider impact assessment of climate change in downstream rivers, which will support new highland-lowland linkages and dialogues on water resource allocation.

2. Participants in the local and national dialogues benefited from opportunities to identify, analyze and discuss their own interests and needs and those of others. Dialogues were successful as indicated by the voices of marginalized stakeholders being heard and responded to by more powerful stakeholders. This will lead to increased participation in decision making, which influences livelihood adaptation and resilience to change; this does not mean that better participatory processes will automatically create better decisions. In general, dialogue participants came away with a deeper understanding of other stakeholders' positions through enhanced capacity for using social learning skills. In Nepal, dialogues resulted in local water user management plans and climate change education curricula; and in China, some of our study results were incorporated into the 3rdnational assessment report on climate change.

Over time, these dialogues could create the conditions for more widespread participation in the region, but not, of course, without support from political leaders.

3. Officials and decision makers benefitted from exposure to a variety of new perspectives on local and regional security gained both from interaction with peers in regional meetings and from information provided by experts and facilitators. A few key leaders now have access to expanded options with which to respond to current and future changes. They may choose not to implement these new options; in the Asian Highlands, there are entrenched interests that may prefer to have the status quo remain for national security or other reasons. And while China has a well-established disaster early warning system, other areas of the Asian Highlands are just beginning to use new knowledge to reduce risks before disasters occur.

4. Colleagues in the Asian Highlands research and development community have a better understanding of the interests that are held by diverse stakeholders in the region. Team leaders and project facilitators have improved skills in implementing and analyzing case studies, local, regional and national dialogue processes and meetings, workshops and conferences involving a wide range of groups from villagers to officials and scientists. These benefits have led to opportunities to pursue new research interests and partner collaborations including the Mountain Future Initiative. At the same time and at a general level, researchers in the region still have few professional incentives to broaden their views beyond their disciplines and use interdisciplinary viewpoints to produce innovative work.

Dissemination

Significant effort was expended on sharing and disseminating results from this project. For Module 1, multiple peer-reviewed papers were published and several conference talks were given. Local, village-level efforts are detailed in the Research Details and Results section for Modules 2 and 3. For Module 4, in 2014, Ed Grumbine and Xu Jianchu visited the recently established Centre for Climate Change (CCC) in Pakistan for multiple meetings, dialogues and information sharing sessions. The Centre was established by Helvetas Swiss Intercooperation in collaboration with the University Of Agriculture Peshawar, Pakistan. The team visited different faculties of the University where presentations on climate change adaptation, water governance and research writing skills were delivered. Both KIB and CCC agreed on long-term collaboration and exchange of delegations. Xu Jianchu offered to select students for PhD and postdoctoral research in KIB under the umbrella of collaboration with CCC. Sehroon Khan, Assistant Professor from the Bio-Technology Department was selected by Xu for a postdoctoral position, and he joined KIB in November 2014.To facilitate other channels for dissemination, Xu Jianchu is an active member of the Indus Forum (formerly: Indus Basin Group) of Abu Dhabi Dialogue (ADD) Process and is also a key member of Mekong-Ganges Dialogue. He attended the 3rd Mekong Ganges Dialogue, 16-17 December 2014, in New Delhi, India to spread project results to this forum; he also attended the Stockholm World Water Week in 2012 and 2013. Robert Zomer and Xu Jianchu organized a session at the International conference on Our Common Future under Climate Change, 7-10 July 2105, Paris. Ed Grumbine gave a keynote speech at a forum attended by many high-level government officials in the Mekong sub region in March 2013. He also co-chaired a regional stakeholders' dialogue at the Mountain Futures conference in Kunming, 1-4thMarch 2016 and chaired a "Policy into Action" session at the same meeting. Su Yufang attended the 7th World Water Forum, 12–17 April 2015, in the Republic of Korea to share the results from the project.

LESSONS LEARNED

1. The results from our biophysical climate modelling indicate that significant impacts can be expected in the Asian Highlands by 2050, including rapid and substantial shifts in the mean elevation of both bioclimatic strata and bioclimatic zones, with likely negative impacts on biodiversity and local farming systems.

2. Local people are already using hybrid knowledge to adapt to water and climate change impacts. "Traditional" knowledge does not exist in isolation from market and government influences.

3. International consensus on good water governance practices exists but this has so far not had much influence in the Asian Highlands.

4. All three countries in the project have strong water laws and policies on paper but implementation is weak. China has strong water projects and infrastructure but does not have adequate local participation.

5. Most of the barriers in 3 and 4 above are due first to state development goals that take little to no account of good water governance practices, and second to inequities in political, social and economic power between people at the local level and decision makers at the state and regional levels. These are political problems that cannot be resolved with technical and scientific information. Resolution requires political influence and timelines that go beyond grant-supported studies.

6. Within the above generalizations, there are differences between the three study sites. Due to these differences, local, near-term success in establishing better water governance is more likely in Nepal, Pakistan and China in that order (for details, see Research Details and Results section).

7. 7. Working for better water governance beyond the local level is challenging—in Pakistan the state is relatively strong but not connected well to the local level, resulting in too many institutional disconnects between policy making and on-the-ground implementation. In Nepal, there exists an abundance of good water policies on paper but good water governance *implementation* has been stymied by intractable disagreement around constitutional issues, party politics and inadequate funding. China also has solid water laws and policies but within China's strong, hierarchical system, there exist few avenues to influence officials on water matters above the village level.

8. Potential tipping points toward better water governance in the Asian Highlands could include: reduced economic growth due to water and climate impacts; rising temperatures that begin to constrain outdoor labor and reduce human work productivity; catastrophic climatic disasters triggering years-long drought; a transboundary food security crisis resulting from hydropower development on the Mekong River (or another river); or some unknown combination of social responses to growing biophysical impacts that might be described as a "tipping point". However, none of the local-level successes resulting from this project are likely to influence *state or regional-level* change over the short to medium term. The one exception to this maybe the scaling up of Water Use Master Plans in Nepal.

9. In the Asian Highlands, incentives for change are not yet strong enough to tip the balance away from a political status quo that so far has placed little value on policies and practices to address water governance across national boundaries (and boundaries between genders, income groups, and rural and urban dwellers). At some unknown point, however, security for any single Asian Highlands state and all nations in the region cannot be supported under conditions of closed information, little transparency, inefficient institutional coordination and limited local participation. The IPCC estimates that regional climate impacts will increasingly be felt after 2030, and our Module 1 analysis suggests that profound changes will be taking place by or before mid-century. (These timelines of change depend somewhat on whether and when emissions will be curtailed through international mitigation efforts.) Overall, these

projections define a rough decision space of five to fifteen years for Asian Highland countries to act on building better water governance.

10. Addressing barriers to better water governance in the Asian Highlands requires several steps. First, one must understand where individual states are positioned on incentives to cooperate, support local participation, provide open information exchange (internally and with other nation-states), and embrace other principles of good governance. Projects that focus only on science and do not account for institutional disincentives to change are unlikely to influence decision makers. Second, one needs to have a plan on how to communicate project results in a clear, politically and culturally sensitive manner. Researchers must understand this and do a much better job of communicating results to non-experts from local people to politicians. A second key is acknowledging that all Asian Highlands countries are in various stages of economic development that will continue to dramatically alter livelihoods and landscapes; effective water governance is about managing, not eliminating change. Each highlands country uniquely interprets ecological and social impacts; this influences government assessment of political risk relative to the social-ecological risks discussed throughout this report. When uncertainty is high, current ecological and/or social impacts appear relatively low, and projected negative consequences are perceived as distant, there is unlikely to be any great momentum for change.

11. The current dominant framework for Asian Highlands water management, Integrated Water Resources Management, pays little attention to the politics behind decision making. Environmental security, on the other hand, focuses on the management of ecosystem, political, economic and social risks that may undercut state stability in the face of change; this may better capture the attention of governments and other high-level stakeholders. The Chinese government is making good progress here and has recently focused on “Eco-Civilization” as a new political mandate, implying movement toward an environmental security perspective. A focus on security may also help to showcase the importance of coordinated action across sectors for mutual economic benefits. However, environmental security is not a panacea and remains untested in any place in Asia.

12. Local efforts at changes in water management may be successful but will ultimately need broader state support in order to create the conditions that lead to better water governance. Otherwise, scaling up local-level success (such as WUMPs) will likely fail. Therefore, despite progress at the local level at our study sites, the future of more effective water governance in the Asian Highlands remains mostly in the hands of the region’s decision makers. Given that healthy, functioning ecosystems provide the services that allow people to respond to change, local people, local governments and local ecosystems will be at increasing risk until more effort is expended on integrating local responses to change with state programs for development and conservation.

TRAINING AND CAPACITY BUILDING

Students

The project provided training and joint research opportunities for core team members, national and local partners and graduate students. This was achieved through a mix of academic work, training workshops, joint field assessments between research partners, local participants and students and various local and regional stakeholder meetings.

Module 1 (China)

Several researchers received training in advanced spatial analysis and hydrological models, including Python computer language and R. In order to tackle the difficulties faced by students in data analysis and research design, we arranged a one week refresher and orientation training on R and R Studio statistical analysis software. In total, 30 participants including students and staff from the project participated in the workshop. Besides the regular support provided to the students engaged in the project, Rabin Niraula from the Nepal team was invited to China for one month and was trained in SWAT modelling.

Module 2 (Pakistan)

In June 2013, 12 graduate students, including 9 from the Abdul Wali Khan University (AWKU) Bacha Khan Campus, Chitral were selected as project interns. These students were at various stages of their degree programs and could link their research topics with our case study. Their selection was based on their aptitude, interest, language skills and basic understanding of household surveys and conducting interviews. During June 2013, these students were thoroughly trained on the basic concepts of hazards, risks and vulnerability, conducting hazard and vulnerability risk assessments and conducting household surveys. Two of these students were selected as interns and were further trained on the Statistical Package for Social Sciences (SPSS). Out of the remaining students, nine were engaged as interns for data collection. One more student joined us from the Institute of Advanced study (IUSS) in Pavia, Italy who had studied the same topic in the Karimabad area of Garam Chashma.

Module 2 (China)

We supported 4 PhD students. They conducted case studies of local adaptive capacity and vulnerability and water governance in Lijiang and Nepal. Another Chinese student worked on agent-based modeling. One North Korean student conducted an ecosystem vulnerability assessment for Yunnan Province in Southwest China. One Pakistani student from Hong Kong Polytechnic University worked on understanding grasslands dynamics in relation to climate variability in the Upper Indus Basin, Pakistan. All of these students received training with the Statistical Package for Social Sciences. Two of the students were trained in agent-based modelling and two of them have also received gender analysis training at an ICRAF gender training workshop. For Lijiang field work, twelve Master's students from Yunnan Agricultural University and Yunnan University for Nationalities were trained in household survey data collection, general knowledge of rural development, relevant government policies and water governance issues.

Module 3 (Nepal)

Researchers involved in this project participated in training sessions aimed at improving their research skills. In 2013, one PhD student was supported and attended five training workshops (science and policy writing, statistics, data analysis and GIS). In 2014, a PhD student received training on hydrological and climate modeling. Three Masters Students worked on (i) Conflict and Harmony in the Institutional Arrangements of Water, Climate Adaptation and Village Development Planning (ii) Gender and Poverty Issues in Water Governance in Water Use Systems in Melamchi and (iii) Financing for WUMP from the Water, Sanitation and Hygiene Sub Sector at the VDC Level. We also held multiple training sessions for local people at the study site. At nine wards in each of four VDCs, we held multiple trainings in

orientation, capacity, assessment, water source mapping, planning and prioritization to WUMP, gender equality, social inclusion and the poverty reduction guidelines used by HELVETAS Swiss Intercooperation.

Rabin Raj Niraula, a researcher involved in the project and affiliated with Kathmandu University has been working for three years on his PhD on "Water Governance and Climate Change Vulnerability in Melamchi Watershed in Central Nepal". During 2013-14, he completed all course work required by the University. He attended various training sessions and workshops as follows:

- Scientific writing training organized by South Asian Institute of Advanced Studies (SIAS), Kathmandu (April 2013)
- STATA – statistical package in data analysis, organized by South Asian Institute of Advance Studies, Kathmandu (October 2013)
- SPSS – statistical data analysis – provided by Kathmandu University (2013)
- Writing for policy – organized by South Asian Institute of Advanced studies (SIAS), Kathmandu (January 2014)
- Application of GIS for mapping social vulnerability (February 2014)
- SWAT Modelling training in KIB, China (July 2014)
- Participation in AOGS conference and oral presentation on "Mapping Vulnerable Springs in the Hilly region of Nepal"
- Submitted a book Chapter on " Community forest management as a driver of land and forest cover change in Nepal", to be published in February 2016

As a joint supervisor to the research, Dr. Bharat Pokharel has been regularly mentoring Rabin Raj Niraula.

Module 4: We had no formal degree program students. However, Ed Grumbine mentored a Tajikistani Master's student from another school in water governance issues based on the results from this project. Ed also provided a one-day training on scientific writing to 30 students at the University of Agriculture, Peshawar during his visit to Pakistan in 2014.

Capacity building. The core team in Kunming has built administrative capacity to better communicate with all team members and provide leadership across this wide-ranging research project. In Pakistan, the entire project has served as a learning ground for young researchers. Local NGO staff, university students and the project team have learned to analyze vulnerabilities and observe associated changes and impacts in the field. Better coordination with other climate projects in the region is growing and is also being supported by IDRC. In Nepal, Module 3 climate education efforts in community schools are increasing teacher and student understanding of climate impacts at the local level. In China, Module 1 has included spatial analysis and remote sensing capacity building for junior team members. In Module 2, participatory and fieldwork skills for learning and implementing case study methods (vulnerability assessment, survey methods and analysis, interview and focus group skills) with local people were shared with young researchers and interns. Module 3 provided agent-based model building training for young researchers and students. Training in planning and facilitating a regional meeting for key stakeholders built capacity for Module 4 team members.

ANNEXES

Annex1: Minutes of the Asian Highlands Water Governance Project Final Meeting, 28 February 2016, Kunming, China

Professor Xu introduction:

- This project will be set overall in the context of the Mountain Future Conference.
- Purpose: to place special emphasis on project results and future support for participatory projects.
- The Mountain Future Initiative is meant to link mountain organizations together.

Model 1 results presented by Robert Zomer:

Outcomes:

- Advancing our knowledge of present and projected impacts of climate change across the AH regions
    - Bioclimatic conditions, hydrologic cycles, terrestrial ecosystems
- Current and projected future impacts on water resources
- Developed a knowledge platform to share relevant climate knowledge with a wider audience

Impacts:

- Develop a regional model for climate and hydrological change: through a multi-model approach (using a public domain global dataset - i.e. WorldClim, or regionally availably data)
- Bioclimatic stratification- impacts on ecosystems
- Based on GEnS- with the GEOSS- GEO- BoN framework:
- Pilot Sites: China, Nepal and Pakistan
- Asian Highlands-10 river basins
- Central Asian
- Lower Mekong basin
- Global Analysis- lead to a future capacity building and future modeling

Outputs:

- Climate change modeling and analysis for AH
- EnS Methodology and Tool Implementation- Dissemination
- Pilot sites analysis: SWAT modeling
- ICRAF papers
- Four major regional reports for decision-makers
- Six peer-reviewed journal articles

Modeling Tool:

- Rapid ecological special assessment tool
- Integrated, high resolution geospatial modeling approach
- Two integrated Models:
    - Bio_Clim_EnS_Model
    - Hydro_Balance Model
- Framework used in this project fits into the Biodiversity observation network
- Tool will be published online in order to increase capacity and future predictions
- This is very user friendly and can analyze 2050 and 2070.
- Xishuangbanna: All available land is converted to rubber production, but climate change will remove the barrier to rubber expansion above 280 meters, putting primary forests at risk

- Yunnan Environmental Protection Department: Biodiversity strategy action plan: looked specifically at protected areas for 15-year plan
- Asian Highlands: Bioclimatic zones will shift to novel bioclimatic regions, rapid ecological change in the near future.
- In general, climatic zones are shifting up by hundreds of meters.
- Lower Mekong: Extreme change everywhere, the more important thing is to understand vulnerabilities; we used species modeling in conjunction with the climatic zone analysis to create a vulnerability analysis.
- Species and niche monitoring: done with 5 crops in Yunnan and coffee and banana in Nepal
- All results and original data are online and can be downloaded, this will be improved in the future
- Dissemination: Atlas for Mountain Futures (1 year project), Mountain Futures Conference, etc.

Model 2 results presented by Arjumand Nizami:
Open remarks: Module 1 is about modeling, but Module 2 is about two things: reality from the ground, and how poor governance can exacerbate climate change issues.
Impact of climate change:
Where are impacts manifested in ethnicity, gender and poverty?
How are farmers adapting to an increased climate change belt?
What areas are people more vulnerable and why?
What are the pros and cons of adaptations options?
What stakeholders engage/which do not?
Is indigenous knowledge still relevant?
Linking modules:
The modules link together based on the results and analysis. All the modules are linked together by exchanges and dialogues; this will not stop with the end of the project but continue across future programs.
Key findings:

- Hazards and Vulnerability risks assessments using CRiSTAL
- HH survey
- Qualitative data around specific topics (from HH and hazard and vulnerability risk assessment)
- Earlier work conducted by Intercooperation
- Publications
- Linkages with water and livelihoods
- Linking modules 1 and 2 with stakeholders' dialogue

Next:

- Publishing
- WUMP in Garam Chashma Chitral
- Climate corridor- work continues with SDC
- Redefining Agro-Ecological zones with SDC: translating Module 1 results for Pakistan
- Water governance as an overriding theme for the Pakistan Program: Our findings suggest not to overlook governance aspect as it contributes to climate change vulnerabilities

Model 3 results presented by Bikram Rana:
Achievements:

- Dialogue model 1
    - WUMP

    - VDC water use master plan
- Dialogue model 2
    - Education in school
- Capacity building: support research
- Publications: Water use master plan and 3R facilitators manual
- Working papers
- Springer book chapter
- Combined documentary: Pakistan and Nepal

Engagement of villagers and local governance:

- Identify springs and existing water service level

Linking modules:

- Information from the other two modules were used to influence climate change policy
- Tools from Module 2: CRiSTAL and surveying to make local projects
- Scientific information from module 1 supports WUMP

WUMP:

- Use participatory approach to verify mapping information to get the most accurate information and policy
- Information brings in voices of the poor
- Integrated negotiations
- Linking famers with the agriculture department
- Also conducted HH survey and ward level, upstream/ downstream linkages
- Important to include water governance in local governance and stakeholders meeting because of the lack of good local water governance

Outputs:

- 4 water use master plans
- Allocation for budget for water
- Changed ad hoc planning based on water master plans, use of resources from Module 1 to strengthen basis for better water governance: Scientific and local information into the planning process.
- Learned the importance of water governance: upstream and downstream collaboration in practice
- Possible action: administration institutions miss dimensions of IWRM
- Bind institutions and dimensions of IWRM into mutual action

Collaboration:

- More WUMP and continuation through dialogue with ICIMOD
- Bring in water tower conservation supported by CGIAR
- Humanitarian support supported by CARITAS, Swiss solidarity plus WASH in schools
- Dissemination: Ministry of science technology and environment
- Various workshops with ICIMOD
- International workshop MUS 25-2
- Water gender and livelihood workshop
- More possibilities

Model 4 results presents by Su Yufang:

Research questions:

- Current situation in the region
- Standards for good governance
- How can governance become more effective
- Transboundary issue in water governance

Methodology:

- General regional literature review
- Climate adaptation
- Water laws & policies
- Water governance review
- New information on hybrid knowledge
- COMBINE results from all 3 sites
- Visited all 3 sites to link to regional big picture view
- Co-chair regional SH dialogue

Linking the results:

Current situation: policies and regional water governance do not coincide

- Governing bodies still dominant the conversation on water governance
- No transboundary water governance
- Continuing lack of political interest to use science to inform policies

Conclusion:

- Policy makers are beginning to talk about water governance
- Good governance needs to look at social, environmental and economic factors
- Good and better water governance are different:
- Focus on *better* water governance
    - Define the role of hybrid knowledge: indigenous and scientific information
    - Coordinate top-down and bottom-up actions

Sites:

- Lack of open information
- Unclear water tenure
- Little accountability
- Need to support women's role and leadership and decision making
  Identify entry points for locally roots initiatives

Next steps: (PPT)

- Global Forum on Agriculture
- IRRIGATION
- Promote cost-sharing w/community input
- Community irrigation OR community+ Gov.?
- DISASTERS
- Mainstream DRR
- Develop district climate adaptation plan
- FOOD
- Better agri. extension services (focus for women)
- Pilot climate crop corridors

Transboundary issues:

- Indus river only current forum for transboundary water governance
- Currently, we have more results but without strategic communication our results do not matter
- Climate change actions: climate change is all about value and politics not so much about new data
- Bottom-up actions important: translate the science and use it to manage conflicts

Accomplishments:

- Peer-reviewed articles
- Working papers
- Presentations
- Provided water governance frame for partners
- Highlighted role of hybrid knowledge
- Linked results from all modules
- Encouraged/participated in dialogues
- Assisted partners as needed (information sharing/editing/communication)

Additional Highlights:

China site presented by Sailesh Ranjitkar:

- Summarize modules
- Spatial analysis: enrich knowledge and develop knowledge platform

Activities:

- Wetland assessment and tree-crop modeling

Achievements:

- New methodology
- Analytical tools for climate and hydrology

Highlights:

- Ground analysis: Add from PPT
- 2 PhD works (directly linked with project); 1 PhD partly related; other training and capacity buildings
- published articles
- identify local vulnerability and resilience of crops
- Stakeholder workshops: hybrid knowledge
- Impacts of scientific and ground impact
- Ecological and niche modeling
- Policy recommendations: used by biodiversity in Yunnan planning for a changing climate using hybrid knowledge; agroforestry suggestions based on climate-tree crop modelling.

Nepal site presented by Rabin Raj Niraula:

Capacity-building:

- Conceptual framework: build the capacity of local government, local people and students
- Research, training modeling , master's research

VDC capacity- local government:

- Planning methods
- Knowledge transfer to adjoining VDC
- V-WAS committee capacity built
- Technical and social facilitators trained

Institutional capacity:

- Social uplift program, compensation program of Melamchi Inter-basin Drinking Water Supply Project
- 8 VDCs in watershed, local government representatives, political parties
- WUMP
- Integrated of local planning
- Key research collaborations
- Spring shed management
- Gender research over WUMP
- Gender sensitivity of house reconstruction

Water user committees:

- 7 water user committees registration in district water resource
- developed operation plan
- solved conflicting issues
- increased ownership and sustainability

Clarify concepts:

- effective (better) water governance
- resource management
- institutional building
- Information

Pakistan site presented by Jawad Ali:

Capacity building:

- Climate change center 2013: established with SDC
- 3 areas: university capacity, government, community
- M2 and M3 links with University of Chitral, University Pavia, university of agriculture
- CCC working with climate corridors
- CCC started to support SDC W4L on hydrological trends
- Many dialogues with locals, government officials and students
  Results:
    - Papers: Making My Village Vulnerable
    - Climate change and Women's place based vulnerabilities – Poor Water Governance Not Geological Change
    - WUMP facilitators; manual SDC initiative
    - En route risk reduction to resilience, Pavia University

Challenges:

- Capacity of local university
- Water planning in Chitral
- Methodological capacities at the national level on climate corridor, water, etc.
- Link KIB students and staff

Remarks from Jianchu Xu:

- Over 4 KIB PhD students have graduate based on this research.
- The capacity difference between Pakistan and China is very great and it is important to continue support for our work there.

- There have been a lot of unrecorded capacities on an ad hoc basis that have benefited from this project, especially at KIB. This has brought a lot of synergy between organizations in the region.

Closing: Bhim Adhikari
Key points:

- The work that has been done from this project can link with many of projects that are running simultaneously.
- Congratulate the team based on all of these successes.
- We still need the final technical report. Please include:
    - Gender
    - It is important to include all aspects of the project both positive and negative because they are a way to learn.
- Adaptive capacity: IDCR wants to focus on climate change and adaptive measures in urban areas in the future.

Closing remarks from Murali Kallur:
Key points:

- There are a lot of lesson that's can be taken for the future and our lessons are important to take into the future.
- While it is good to look at scientific knowledge, we need to focus on local adaptations because they have knowledge that we often don't understand. We need to look at how we can nurture this indigenous knowledge.
- Sincerest congratulations, this is not easy; it is important for moving forward.

Closing remarks from Jianchu Xu:
Key Points:

- It is difficult to wrap up this project.
- Thank you for all of your work.
- We would like to continue our collaboration with you all.
- We need all modules in place in order to have specifics and demonstrate the bigger picture.

Annex2: Milestones: Building Effective Water Governance in the Asian Highlands

0 to 6 months: First joint technical progress report submitted with details on the following:

- Research teams and project partners in place with clear roles defined
- Inception workshop held (Kunming) and communication strategy, M&E plan finalized
- Analysis of MODIS time series data and regional climate data completed
- Development of downscaled climate scenarios initiated
- Development and pilot testing of social vulnerability assessment tool
- Land-use and hydrological assessments in selected watersheds initiated
- Details for post-graduate student requirements finalized and shared with participating academic institutions
- Project steering committee established

6 to 18 months: Second joint technical progress report submitted with details on the following:

- Analysis of impacts of climate change on wetlands completed
- Household surveys on vulnerability assessment completed
- Focus group discussions and participatory mapping exercises in case study sites
- Baseline meta-analysis of all biophysical data completed and one peer reviewed publication developed
- Institutional analysis for transboundary water governance undertaken
- MA and PhD students selected and in place
- Knowledge sharing platform and project website developed
- First project steering committee meeting and mid-review workshop held (Nepal)

18 to 30 months: Third joint technical progress report submitted with details on the following:

- Stakeholder dialogues at local, district levels held and model developed
- Vulnerability and livelihood analysis completed
- Downscaled climate models and water security scenarios developed
- Local water resource management plans developed
- Research links to local and national climate adaptation policy and planning established
- Environmental education outreach through local schools initiated
- Two scientific peer-reviewed publications finalized, including one based on vulnerability analysis

36 months: Final technical report submitted:

- Regional meeting on transboundary water governance organized
- Scientific and policy briefs prepared and translated in local languages
- Two peer review publications, including one on transboundary water governance in the context of climate uncertainty finalized
- Data visualization and audio visual resources finalized
- Up to 10 Masters dissertations completed and four doctoral theses nearing completion
- Final project conference for regional dissemination of research results held

Annex3: List of publications

Peer Reviewed Journal Articles:

Ranjitkar, S., Sujakhu, N. M., Lu, Y., Wang, Q., Wang, M. C., He, J., Mortimer, P. E., Xu, J. C., Kindt, R., Zomer, R. (2016).Climate modelling for agroforestry species selection in Yunnan Province, China. Environmental Modelling & Software, 75, 263-272. doi:10.1016/j.envsoft.2015.10.027

Sujakhu, N.M., Ranjitkar, S., Niraula, R.R., Pokharel, B.K., Schmidt-Vogt, D., Xu, J.C. (2016). Farmers' Perceptions of and Adaptations to Changing Climate in the Melamchi River Valley of Nepal. Mountain Research and Development, 36,1-18.doi:10.1659/MRD-JOURNAL-D-15-00032.1

Zomer, R. J., Xu, J. C., Wang ,M. C., Trabucco, A., Li, Z. Q. (2015).Projected impact of climate change on the effectiveness of the existing protected area network for biodiversity conservation within Yunnan Province, China. Biological Conservation, 184, 335-345. doi:10.1016/j.biocon.2015.01.31

Zomer, R. J., Trabucco, A., Metzger, M., Wang, M. C., Oli, K. P., Xu, J. C. (2014). Projected climate change impacts on spatial distribution of bioclimatic zones and ecoregions within the Kailash sacred landscape of China, India, and Nepal. Climatic Change. doi: 10.1007/s10584-014-1176-2

Zomer, R. J., Trabucco, A., Wang, M., Lang, R., Chen, H., Metzger, M., Smajgl, A., Beckshafer, P., Xu, J. C. (2014). Environmental Stratification to Model Climate Change Impacts on Biodiversity and Rubber Production in Xishuangbanna, Yunnan, China. Biological Conservation, 170 (2014), 264-273. doi: 10.1016/j.biocon.2013.11.028

Li, Z. Q., Xu, J. C., Shilpakar, L. R., Ma, X. (2014). Mapping wetland cover in the greater Himalayan region: a hybrid method combining multispectral and ecological characteristics. Environmental Earth Sciences, 71, 1083–1094.doi 10.1007/s12665-013-2512-y

Ma, X., Lu, X. X., Noordwijk, M. V., Li, J. T., Xu, J. C. (2014). Attribution of climate change, vegetation restoration, and engineering measures to the reduction of suspended sediment in the Kejie catchment, southwest China. Hydrology and Earth System Sciences, 18, 1–16. doi: 10.5194/hess-18-1-2014

Ma, X., Xu, J., & Su, Y. (2014). Water Resources Vulnerability Assessment in the Yanggongjiang Watershed in Lijiang, China (in Chinese). Journal of Environmental Sciences, 33(6), 60–66. doi:10.13623/j.cnki.hkdk.2014.06.015

Xu, J. C., &Grumbine, R. (2014). Integrating local hybrid knowledge and state support for climate change adaptation in the Asian Highlands. Climatic Change, 124, 93-104.doi: 10.1007/s10584-014-1090-7

Xu, J. C., Grumbine, E. (2014). Building ecosystem resilience for climate change adaptation in the Asian highlands. WIREs Climate Change, 5,709-718.doi: 10.1002/wcc.302

Grumbine, R.E. (2014). Assessing environmental security in China. Frontiers in Ecology and the Environment. doi: 10.1890/130147

Grumbine, R. E., & Xu, J. C. (2013). Recalibrating China's environmental policy: The next ten years. Biological Conservation, 101, 1214–1224 .doi: 10.1111/1365-2745.12132

Y. Su, J. Hammond, G. B. Villamor, R. E. Grumbine, J. Xu, K. Hyde, . Pagella, N. M. Sujakhu & X. Ma (2016): Tourism leads to wealth but increased vulnerability: a double-edged sword in Lijiang, South-West China, Water International, DOI: 10.1080/02508060.2016.1179523.

H. Yang, G. B. Villamor, Y. Su, M. Wang, J, Xu (in coming): Land-use response to drought intervention in Lijiang, SW China. Land Use Policy. Accepted.

Working and Conference Papers:

Zomer, R.J., Trabucco, A., Wang, M. C., Xu, J.C. (2016). Projected Climate Change Impact on Hydrology, Bioclimatic Conditions, and Terrestrial Ecosystems in the Asian Highlands. ICRAF Working Paper

222. World Agroforestry Centre East and Central Asia, Kunming, China. 56 pp. doi:10.5716/WP16006.PDF

Zomer, R.J., Wang, M.C., & Xu, J.C. (2015). Projected climate change and impact on bioclimatic conditions in Central and South-Central Asia. ICRAF Working Paper 187. World Agroforestry Centre East and Central Asia, Kunming, China. pp 50. doi: 10.5716/WP14144.PDF

Grumbine, R. E., Nizami, A., Tharu, B. R., Salim, M.A., Xu, J.C. (2015). Mobilizing Hybrid Knowledge for More Effective Water Governance in the Asian Highlands. ICRAF Working Paper 197. World Agroforestry Centre East and Central Asia, Kunming, China. 20 pp. doi: 10.5716/WP15012.PDF

Grumbine, R. E., Nizami, A., Tharu, B. R., Niraula, R., Su, Y. F., Xu, J.C. (2015). Water Governance in the Asian Highlands. ICRAF Working Paper 198. World Agroforestry Centre East and Central Asia, Kunming, China. 25 pp. doi: 10.5716/WP15013.PDF

Ranjitkar, S., Sujakhu, N.M., Budhamagar, K., Rimal, S., Xu, J. C., Merz, J., Zomer, R. J. (2015). Projected climate change impacts on climatic suitability and geographical distribution of banana and coffee plantations in Nepal. ICRAF Working Paper 204. Kunming, China. World Agroforestry Centre East and Central Asia. 32 pp. doi:10.5716/WP15294.PDF

Su, Y. F., Grumbine, R. E., & Hyde, K. (2014). Building better water governance in response to climate change and water stress: A case study of Lijiang, Yunnan Province, China. ICIMOD (International Centre for Integrated Mountain Development), Kathmandu, Nepal.

Ali, J., Nizami, A., Ara, R., Salim, M. A. (2015). Hydro-meteorological hazards, vulnerabilities and coping strategies in Garam Chashma Chitral - Pakistan. Islamabad: Intercooperation Pakistan.

Asad, M., Wali, S., Hassan, S., Salim, M. A., Ara, R. (2015). Hazards and coping strategies in Chitral Pakistan - a case study of villages from Garam Chashma. Islamabad: Intercooperation Pakistan.

Tharu, B. R., Merz, J., Niraula, R. R., Pokharel, B., Sherpa, M. (2016). Practicing IWRM at Local Level – Implementation of Water Use Master Plan. Working Paper. HELVETAS Swiss Intercooperation Nepal.

Under review and others:

Grumbine, R. E., & Xu, J.C. (2016). Challenges and Opportunities for Transboundary Environmental Security in the Mekong River Basin. Chinese conservation, Biological Conservation. (Under review)

Sujakhu, N.M., Ranjitkar, S., Niraula, R.R., Salim, M.A., Nizami, A., Schmidt-Vogt and, D., Xu, J.C. (2016). Impact of climate change and water induced hazards on agriculture-based livelihood in the Asian Highlands. Water International. (Under review)

Ali, J., &Nizami, A. (2015). Making my village vulnerable. Water Governance and the Myth of Increased Hazards in Chitral, Pakistan (under review)

Nizami, A., & Ali, J. (2015). Climate change, gender roles and vulnerabilities – a case study from Pakistani Highlands (under review)

Ranjitkar, S., Sujakhu, N. M., Merz, J., Xu, J. C., Matin, M.A., Ali, M., Kindt, R., Zomer, R. (2016). Suitability analysis and projected climate change impact on banana and coffee production zones in Nepal. PLOS ONE. (Major revision)

Tharu, B. R., &Niraula, R. R. (2015) Information for dialogue shaping water resource management, adaptation and governance. NPRN. (Submitted)

Kim, K, Wang, M., Liu, S., Ranjitkar, S., Xu, J., Zomer, R. (2016). Use of leaf area index (LAI) to assess vegetation response to drought in Yunnan province of China. Journal of Mountain Science (Submitted).

Zomer, R. J., & Wang, M.C. (2014). Projected Climate Change and Impact on Bioclimatic Conditions for Terrestrial Ecosystems, and on BSAP Priority Areas and the Protected Area Network within Yunnan Province, China. In: YEPD. Biodiversity Strategy and Action Plan for Yunnan Province, the

People's Republic of China (PRC)". Yunnan Environment Protection Dept. Kunming, Yunnan. June 27th, 2014

Ma, X., Wang, M. C., & Zomer, R.J. (2015). Building Effective Water Governance in the Asian Highlands: Module One - Impacts of climate change on hydrological processes in Lijiang case study. Centre for Mountain Ecosystems Studies, Kunming Institute of Botany / World Agroforestry Centre, Kunming, China. March 28th, 2015

Water Use Master Plan + 3R – Facilitators Manual. (2015). HELVETAS Swiss Intercooperation Nepal.

Discovering Common Ground in Climate Change Impacts and Adaptation: Lessons from the Asian Highlands and the Southern Colorado Plateau. 13th Biennial Conference of Science and Management on the Colorado Plateau and Southwest Region. Northern Arizona University, Flagstaff, AZ. October 2015.

Report for Yunnan environmental department.

Grumbine, E. D. gave one keynote address- "Transboundary Management Issues in the Mekong Basin". Mekong Environmental Symposium, Ho Chi Minh City, Vietnam, March 2013, along with five other talks to classes and seminars in the region.

Annex4: Overview of the Mountain Futures Conference

The Mountain Futures Conference took place from 1-4 March 2016 in Kunming, China, with the aim of identifying new ways to generate positive social and environmental change for mountain landscapes and peoples. Over 150 researchers, representatives of mountain communities, government officials, donors, and NGOs from Asia, Africa, Latin America and Europe came together to share their visions of mountain futures and develop the means to achieve them.

The conference began by setting out the challenges faced by mountain communities and their potential to foster innovation. Speakers at the opening High-Level Roundtable reminded participants of the mountains' multiple roles: providers of ecosystem services, harbours of biodiversity, centres' of spiritual reverence and storehouses of valuable traditional knowledge. ICIMOD's Eklabya Sharma pointed out that the watersheds of the Hindu Kush-Himalaya region feed rivers that serve the needs of almost 4 billion people. At the same time, mountains face increasing pressures including climate change and biodiversity loss, rural-urban migration, and a lack of recognition and investment from policymakers.

The conference's first plenary session set the context for addressing these challenges: in the age of the Anthropocene, humans are one of the primary drivers of change on earth. Yet too often, this leads to dystopian visions of the future which take little account of the agency of mountain communities. As Laura Pereira of the University of Cape Town explained, alternative positive visions can be developed through identifying and nurturing "seeds of a good Anthropocene": practices, ideas and initiatives which could serve as the foundations of positive futures for mountain regions. The conference should therefore be seen as a means of both sharing these innovative ideas, and of developing new mechanisms for their future collection and development.

The exchange of ideas and learning lessons from past experience were at the forefront of some of the conference's first parallel sessions, including presentations by young researchers of new methods for monitoring and assessing change in the mountains, the results of assessment programmes by ICIMOD, MRI and UNEP, and a session evaluating resource management practices in Central Asia. A special session on "seeds" sparked discussion by testing ideas against different future scenarios, forming coalitions between different seeds and then ranking their performance. A variety of initiatives were compared and evaluated, including a mobile app to help limit damage from natural disasters, a locally produced bio-pesticide, and meso-scale governance platforms to support small-scale sustainable practices.

The second day of the conference focused first on the theme of governance: discussions on community-based conservation, sustainable forest management and the use of wild fungi took place alongside an examination of transboundary water governance in the Asian Highlands. Several speakers emphasized the need for dialogue and networks that cut across national boundaries: as Nisar A. Memon, former federal minister of Pakistan, noted: ""we cannot partition mountains or water: they straddle borders and cross divides". Talk of governance was followed by talk of power at the center and margins: in particular, how to rethink approaches to development in ways that integrate the priorities of marginalized groups, traditions and concepts. Discussions ranged around diverse topics such as on shifting gender roles in the context of climate change, working with spiritual leaders to protect sacred mountain landscapes, revitalizing farming systems with a combination of scientific and traditional knowledge, and drawing on local stewardship practices to establish international networks of mountain farmers. Many of these debates emphasized the necessity of tackling established power relations, of thinking critically about our own assumptions, and of being prepared for complex, long-term commitments in order to bring about change.

The following day brought participants out of the conference rooms for a visit to a project site, where a mining company is working with the World Agroforestry Centre and Kunming Institute of Botany to develop new ecosystem rehabilitation techniques. This was followed by cinema showings of several films which examined the tensions between traditional mountain livelihoods and aspects of modern life such as tourism, resource extraction and consumerism. Filmmakers and representatives of the local communities featured in the films joined the audience for discussion of the issues raised.

The fourth and final day of the conference focused on how to translate research outputs and policy goals into actions that make a real difference to lives and environments in mountain regions. Dietrich Schmidt-Vogt, from the University Of Central Asia, made the point that in "an era of accelerated change, sustainability must be a dynamic concept, but that adapting to changing conditions may not be enough": we must also seek to change our surroundings by planting and nurturing the seeds of future solutions. Several speakers examined the challenges of engaging with policymakers in order to achieve results, while research from the Himalayan Climate Change Adaptation Programme, as well as examples from Nepal, Pakistan, China and Uganda provided grounds for much discussion on how to implement high-level goals into locally appropriate actions.

The conference also laid the foundations for future projects including: a book illustrating the potential for mountain regions to serve as incubators of future solutions; a documentary featuring interviews of participants sharing their visions for mountain futures; and the Mountain Futures Initiative, which will establish a sustainable mechanism for identifying and developing seeds of positive mountain futures.

Annex5: Project linkages

This project has played an important role in research into the livelihoods and environments of the Asian Highlands, and especially in the pilot countries of China, Nepal and Pakistan. Long-term academic and research collaboration among project partners has been strengthened, and capacity building work to enable international students and their mentors to complete their research to international standards has been carried out. The project has enabled the expansion and strengthening of existing relationships with local governments, NGOs, research and academic institutes that enables ongoing contributions to water resource planning and governance policy and planning.

Building on already-established strengths and capacities, the project contributed to the further development of the Centre for Mountain Ecosystem Studies (CMES), the applied research laboratory jointly managed by the World Agroforestry Center (ICRAF) and the Kunming Institute of Botany/Chinese Academy of Sciences. CMES scientific staff gained from research interactions with development-focused partners leading modules 2 and 3. CMES also had close collaboration with the National Climate Centre of China to build knowledge and skills in modeling associated with Module 1.

The National Climate Centre of China within the China Meteorological Administration has mandates in monitoring and assessment of climate change, but little experience in communicating scientific results to the general public. Through participating in the web-based portal, the Centre gained experience in broad communication skills.

The project was helpful in strengthening capacity within HELVETAS Swiss Intercooperation and its local and regional partners regarding the use of scientific monitoring and impact assessments of climate change to tie together and strengthen general social development work. The project provided support to HELVETAS Swiss Intercooperation to integrate scientific research with vulnerability assessments to create more fully integrated policy options for decision makers.

Beyond this specific study and using current initiatives at CMES, we want to use this work to stimulate project partners to begin groundwork for an Asian Highlands/Regional Center(s) of Excellence on integrated climate science and policy. We plan to harness the momentum from this project to target policy and decision makers in the region to institutionalize greater support for ongoing climate change adaptation. We plan to link the results from this project to existing global climate change adaptation programs so that the Asian Highlands are better served by international efforts to reduce water-induced risks and increase resiliencies.

Partnerships

Module 1 workers forged important links with teams based in Kathmandu and Pakistan, the China Climate Centre (Beijing), as well as collaboration with the University of Edinburgh (Dr. Marc Metzger), the Center for Climate Change in the Mediterranean (Dr. Antonio Trabucco) and Centre for Climate Change at the University of Agriculture Peshawar. Partners have been sent all preliminary results relevant to their site to share with local stakeholders.

For **Modules 2 and 3,** in Pakistan, the project was linked with the SDC-funded Water for Livelihoods Programme and the Livelihoods Programme Hindukush, the Aga Khan Rural Support Programme, National Centre of Excellence in Geology Peshawar, Institute of Advance Study (IUSS) Pavia, Abdul Wali Khan University, Bacha Khan Campus Chitral, government line agencies and local support organizations. In **China**, partnerships have been formed with this project at city, district, township, village and household levels through interviews, workshops, and communications etc. We also are working with Grace B. Villamor, Senior Researcher at University of Bonn, Germany and Data Analyst and Mr. Liu Song, who are supporting ongoing VACA household survey data analyses and Agent-based Modelling efforts.

In **Module 3** in Nepal, local partners were the national NGO Centre for Environment Education Nepal (CEEN) and the local NGO Community Development and Environment Conservation Forum (CDECF). These partners have led multiple training sessions during the project. These included: training for technical and social facilitators for each VDC; conducting workshops in orientation to the project, community research methods, water and sanitation issues, basic education in adaptation, climate issues and water governance, and social assessment at VDC and Ward levels in 9 wards of each of 4 VDCs. ICIMOD through their Koshi basin project are collaborating with us for preparation and implementation of another 4 WUMPs in Melamchi valley.

Module 4 served to create especially strong links between the team members/modules in this project. Also productive were new relations with the Centre for Climate Change in Pakistan.

Annex-6 List of participants during project meetings

November 2013

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Steering Committee			
Sara Ahmed	IDRC	IDRC Program Manager	sahmed@idrc.org.in
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